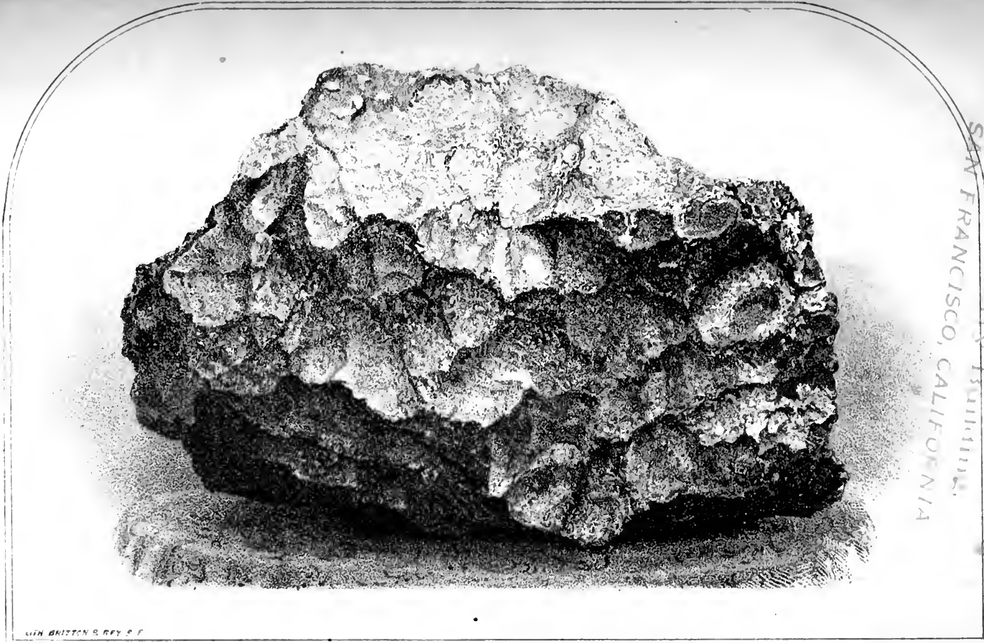


THE SAN BERNARDINO METEORITE.

As Originally Found. Weight 1870 Troy Ounces. One Third Actual Size.

SEE "METEORIC IRON".

THE SAN BERNARDINO METEORITE.

Showing Cut Face And Widmanstattian Figures. One Third Actual Size.

SEE "METEORIC IRON".

CALIFORNIA STATE MINING BUREAU.

Henry G. Hanks, State Mineralogist.

FOURTH ANNUAL REPORT

OF THE

STATE MINERALOGIST

For the Year Ending May 15, 1884.

SACRAMENTO:
STATE OFFICE, ... JAMES J. AYERS, SUPT. STATE PRINTING.
1884.

To his Excellency GEORGE STONEMAN, *Governor of California:*

SIR: I have the honor herewith to submit to you the fourth annual report of the State Mineralogist of California, in compliance with section three of an Act of the Legislature, entitled "An Act to provide for the establishment and maintenance of a Mining Bureau," approved April 16, 1880.

I have the honor to be, very respectfully,

HENRY G. HANKS,
State Mineralogist.

SAN FRANCISCO, June 15, 1884.

REPORT.

For the past year, satisfactory progress may be reported.

The Mining Bureau still continues to occupy the rooms No. 212 Sutter Street, although they are unsuited for the purpose, for the reason that the danger of fire is very great, as mentioned in the last two reports, and alluded to again because the State Mineralogist feels it his duty to warn the people of California of the danger of destruction by fire of the now very valuable Museum and Library, which could never be replaced if destroyed. It is to be hoped that the next Legislature will give this matter their serious consideration. The situation of the Museum over a stable causes other inconveniences, such as disagreeable ammoniacal and hippuric odors, and disturbance of arranged specimens in the cases, by the jarring made by the hoisting of hay by tackles attached to the under side of the Museum floor. The California State Museum is well worthy of a good and thoroughly fireproof building.

MUSEUM.

The Museum has grown beyond all expectation, and it is a question if any similar institution has gained so rapidly as this. This has been the subject of remark by strangers visiting the rooms, on being informed that the collections had been made within four years, and it is for this reason that the specimens have not been so fully classified as the management would wish. Specimens come in faster than they can be arranged and entered in the catalogue, and many fine, valuable, and interesting specimens have been temporarily laid away in drawers awaiting the careful attention that must be given, before they can be assigned to cases in the Museum. There are 6,000 specimens now on the catalogue, or arranged and ready for such entry.

PUBLICATIONS.

The three former reports have been wholly distributed. The rule adopted by the Mineralogist has been to deliver to all applicants, either personally or by letter, a copy of the report, unless he or she has already received one. A large proportion has been distributed by members of the State Legislature, and now many applications are received from the Eastern States and from abroad which cannot be supplied. The publications of the Mining Bureau should be sold at actual cost—a plan adopted by the State of Pennsylvania for the distribution of the publications of the Second Geological Survey, and the money resulting from the sale of publications returned to the State Treasury. Should this plan be adopted, more money should be placed at the disposal of the State Mineralogist, to enable him to furnish more information and to produce better reports by employing competent assistants, and means to travel within the State, to gather personally information bearing on the mineral interests of the State. All the reports thus far, have been made under great difficulty from causes set forth in former reports.

LIBRARY.

The Library now contains 257 works in 602 volumes. Of maps, atlases, views, and large photographs, there are 156; besides which there are a large number of pamphlets, circulars, mining companies' reports, proceedings of societies, etc., arranged in uniform shelf files. If these were bound, they would add largely to the Library. A catalogue of the books, maps, and photographs is now in the hands of the State Printer, and when printed will be the first library catalogue published.

The following newspapers have been sent to the Mining Bureau gratuitously:

1. Engineering and Mining Journal, New York.
2. Mining Record, New York.
3. Mining Review, Chicago, Illinois.
4. Economist, Boston, Massachusetts.
5. Daily Report, San Francisco, California.
6. Daily Grass Valley Union, Nevada County, California.
7. Daily Eveuing Gazette, Reno, Nevada.
8. Sierra County Tribune, California.
9. Humboldt Standard, Eureka, Humboldt County, California.
10. Inyo Independent, Inyo County, California.
11. Arizona Gazette, Phœnix, Arizona Territory.
12. Ventura Free Press, San Buenaventura, California.

No special effort has been made to add to the collection of books, but the importance of having an extensive library of reference on all subjects relating to mining, mineralogy, palæontology, and general geology, open to the public, has never been lost sight of. A few rare and important books have been obtained by purchase, a considerable number by donation, and others by exchange. Now that the publications of the Bureau are in demand, it is to be hoped, and it is confidently expected, that publications of foreign and domestic societies and institutions will be sent in exchange. Quite a number of such exchanges have already been received.

VISITORS.

The names of 14,165 visitors have been entered on the Museum Register up to May 15, 1884, the date of this report. This does not by any means indicate the number of visitors, for the reason that many do not care to enter their names, and many who frequently visit the Museum decline to register after the first time. If some method had been adopted from the first to register all who have visited the Museum, the number would have been very largely in excess of the entries.

DONATIONS.

The following is a list of donors who have contributed to the Museum during the past four years. Many have given a number of specimens, some have contributed largely, and many of the donations are of great value. The name of Mr. J. Z. Davis appears 368 times in the catalogue, although but once in this list. Other names appear many times. It would be impossible here to enumerate all the specimens given by each donor. This information can be gained by referring to the catalogue, or the museum cases:

LIST OF DONORS.

Acker, E. O. F.
Alderman, E. M.
Allen, C. F.
Allen & Lewis.
Allen, W. D.
Aldrich, H. A.
Abbott, Henry.
Alexander, L. L.
Alexander, A. M.
Alexander, F. H.
Amick, M. J.
Ambler, S. F.
Ames, F. W.
Andrews, L.
Arey, Captain R. B.
Atchison, L. E.
Attosen, Mr.
Attwood, M.
Attwood, Frank.
Armstrong, W. T.
Ayres, Wm.
American Museum of Natural History.

Ballarat School of Mines.
Bacon, John P.
Barber, Dr.
Baird, C.
Barney, Jas. M.
Barnard, Charles.
Baker, J. H.
Bailey, J. W.
Balch, Henry.
Banghart, W.
Barnes, Edward.
Barton, W. H.
Battersby, Capt. R.
Barnes, E. G.
Balser, Geo.
Barstow, A.
Barton, B. F. & Co.
Banks, Chas. W.
Barnard, Jno. K.
Basse, Louis.
Bassett, Wm. D.
Bateman, A.
Barnes, Elisha.
Bell, John.
Behrens, J.
Bevan, W. J.
Benjamin, F. A.
Benton, W. F.
Beard, C.
Beardsley, Geo. F.
Begon, L. de.
Belknap, D. P.
Beatty, T. N.
Berger, C.
Blair, A. W.
Bluxome, Isaac.
Blanding, Mr.
Bleasdale, John I.
Blinn, Marshall.
Blackburn, D.
Blair, M. Y.
Blake, W. P.
Blade, S. P.
Bigelow, C. L.
Bilty, Theo. G.
Bixby, Jno. F.
Bingham, Adolph.
Bosqui, E.
Boynton, U.
Bowie, Aug. J., Jr.
Bowman, J. E.
Bock, H.
Borden, R. V.
Boushey, Stephen.
Boyd, Mrs. A.
Boyd, John F.
Bogart, O. H.
Booth, Edward.
Brumagim, J. W.
Brumagim, Miss Blanche.
Brumagim, Miss Jennie.
Brumagim, Mark.
Brastow, S. D.
Bryant, W.
Brooks, H. S.
Brown, Chas. W.
Brown, W. D.
Brown, W. G.
Broome, Wm., Jr.
Briggs, Rev. Mr.
Brownell Bros.
Brannan, Wm.
Brady, R. H.
Burns, Hon. D. M.
Butler, J. H.
Bush, Mrs. A. E.
Burke, Morris.
Buckingham, N. D.
Bunker, W. M.
Burrows, H. L.
Bullock, L. L.
Buswell, W. J.
Burkhardt, Max.
Buckley, Capt. T.
Burch, E.
Burke, W. F.

Callahan, H. B.
Calmes, Mr.
Capp, Chas. S.
Carpenter, Ezra.
California Iron Company.
California Cement Company.
California State Geological Soc.
Calvert, John.
Carmany, J. H.
Casanueva, F.
Casarello, J.
Caldwell, H. M.
Cain, J. W.
Classen, J. M.
Clarke, Wm.
Clark & Sons.
Clark, R. R.
Chilaud, E.
Church, A. S.
Chauvin, E.
Chalmers, Lewis.
Cherry, Wm.
Chase, Lt. A. M.
Clements, Mrs. Joseph.
Cincinnati Soc. Nat. History.
Coleman, W. T.
Collins, J. W.
Collins, S. W.
Collins, S. P.
Collins, R. M.
Collins, John.
Collins, C. J.
Cole, A. M.
Comstock, Charles H.
Connelly, T. F. A.
Coughlin, J. D.
Coleman, N. J.
Cox, Lon.
Costa, Lewis.
Connor, S. P.
Cook, E. W.
Cohen, Richard.
Colerich, J. R.
Cooledge, C. C.
Cooke, J.
Coe, J., Jr.
Coolidge, Capt. J. A.
Cornish, Mark.
Corcoran, Phillip.
Cook, Prof. George H.
Coffin, Mrs. M. M.
Cohen, Mrs. Morris.
Coburn, S. A.
Cook & Spinks.
Cogswell, L. M.
Cook, Seth.
Cobb, H. A.
Comstock, A. M.
Cohen, M.
Cozzens, D.
Cresswell, John.
Cresswell, Mrs. J.
Crane, E. M.
Craig, W.
Crane, L. E.
Crossman, J. H.
Cronise, W. H. V.
Culver, J. H.
Cutting, E.
Curtin, A.
Cutler, Cyrus.
Cummings, George.

Cummings, Frank.
Currie, Wm.

Davenport Academy of Sciences.
Dana, D. S.
Dana, A. W.
Daggett, John.
Davis, J. Z.
Davis, N. S.
Davis & Cowell.
Davies, Phillip.
Daunet, I.
Day, Mrs. H. H.
Decker, Peter.
De Goha, J. W.
Department of the Interior, United States.
Dewoody, J. F.
Dietzler, Gen. Geo. W.
Dixon, John.
Donnelly, Dr. E.
Dore, M.
Dolan, J. J.
Dorman, Levi.
Donough, T.
Doran, R.
Du Bois, P. C.
Dunn, R. L.
Drake, Frank.
Dufresne, J. P.
Durden, H. S.
Durbrow, H. K.

Eger, Dr. L.
Edman, J. A.
Eissler, M.
Electric Man'fg Co.
Elmore, R. P.
Eldridge, H. C.
Eleau, H.
Ellis, John E.
Elliott, Andrew.
Elwyn, F.
Elzy, E. J.
Emersly, J. D.
Emerson, Geo. W.
Engels, H. A.
Enright, Jas.
Ergels, H.
Everett, Jas. W.
Everett, T. B.
Ewing, Thos.

Fair, J. G.
Farrington & Moss.
Faulhaber, C.
Fay, Caleb T.
Faust, H. W.
Febiger, C.
Fernbach, Victor.
Ferris, D. C.
Ferris, C. F.
Figuera, L.
Figel, Phil I.
Filcher, J. A.
Finch, Dr. W. W.
Finlayson, James R.
Fisher, J. M.
Figg, E. P.
Flanagan, L. T.
Fleming, John.
Flick, Wm. F.
Flood, J. C.
Floyd, Jas. G.
Floyd, Thos.
Folingsby, T. H.
Ford, Millen.
Fowler, William.
Fowler, C. C.
Foye Bros.
Fracker, A. H.
Franconi, L.
Franconi, F.
Frank, C. J.
Franklin, E.
Fraser, C.
Frenzel, E. A.
Fresno Enterprise Company.
Friend & Johnson.
Friend, Charles W.
Frost, C. W.
Frost, J. S.
Frost, S. W.
Fulweiler, F.
Fuller, O.
Fulton, R. L.
Funda, Mrs.

Galbreath, R. H.
Gale, Charles G.
Garber, John.
Galbergue, Mr.
Gale, Mrs. A. S.
Gallagher, Ewd. A. T.
Gallagher, Frank.
Gallagher, Hugh.
Gardner, G. W.
Gardiner, Robert.
Gascoyne, W. J.
Gashwiler, J. W.
Gates, Harry.
Gannon, Patrick.
George, Dr. S. G.
George, Arthur T.
Gerold & Weidenhofer.
Garratt, W. T.
Germon, A. & Co.
Ghisculius, George R.
Gladding, McBean & Co.
Glass, Louis.
Gibbes, Charles D.
Gibbons, Miss E. P.
Gilmore, Thomas.
Godfrey, Jas. T.
Golden Gate Plaster Mill.
Goldstone, L. P.
Gonzales, A.
Gorley, Captain H. A.
Gould, James.
Gove, A. W.
Gourguet, Mr.
Gosland, Mr.
Goodwin, Charles.
Grattan, Miss B. A.
Grattan, Mrs. M. H.
Grayson, Geo. W.
Grace, Joseph.
Graham, J. M.
Grattan, W. H.
Graves, Hon. W. J.
Green, J. C.
Green, H.
Green W. H.
Griffith, Griffiths.
Griffin, Thomas.
Griffin, J. B.
Grigsby, R. F.
Grogan, M.
Gummer, W. P.
Gunn, B. M.
Gutzkow, Fr.
Gwynn, Chas.

Haft, E. E.
Haggin, J. B.
Hague, Capt. J. C.
Haher, E. C.
Hahn, E. C.
Hain, E.
Hale, Wm. E.
Haley, S. B.
Hall, Wm.
Hall, J. R.
Harford, Wm. G. W.
Harford, John
Hartson, C.
Hawes, G. H.
Harris, W. N.
Harrison, B. A.
Hawkshurst, H.
Hartley, H. H.
Harvey, Dr. P.
Hartson, C.
Hart, R. G.
Harben, M.
Havens, A. W.
Harmony Borax Company.
Hazen, Gen. Wm. B.
Hearn, Dr. F. G.
Healy, Chas. T.
Healy, Lt. M. A.
Heald, E. P.
Hendy, Joshua.
Henderson, Geo.
Henderson, J., Jr.
Hensley, John.
Heuter Bros. & Co.
Hellman, W. M.
Hellings, W. B.
Herendeen, Capt. L. N.
Herrick, R. E.
Herrick, W. F.
Heydenfeldt, Judge S.
Heydenfeldt, S., Jr.
Heverin, M.
Hicks, J. K.
Hiscox, H. O.
Hittell, John S.
Hoagland, Osborne & Co.
Hoagland, Jas. A.
Hobart, J. H.
Hobson, J. B.
Hoitt, J. S.
Holcombe, S. E.
Holden, G. A.
Holmes, A. J.
Holmes, H. T. & Co.
Holt, J. H.
Holt, Mrs. John H.
Holt, W. H.
Horton, Mr.
Howe, H. M.
Howell, L. V. B.
Howland, B. F.
Howland, W. F.
Hollis, Wm.
Holliday, S. W.
Hood, G. W.
Hughes, Dr. C. B.

Hughes, C. A.
Hughes, D. T.
Huggin, J. D.
Hulford, E. W.
Hullings, M.
Hume, Geo. W.
Hunter, Thos. G.
Huntley, Wm.
Hurley, Horace.
Hyde, H. C.
Hyde, Wm. B.

Idaho Mining Company.
Isham, J. G. B.

Jacks, David.
Jackson, R. D.
Jacobi, M.
Jacques, Mrs. Jas.
Jaquith, A.
Jacobs, A.
James, C. A.
James, Chris.
James, D. B.
Jenney, Walter P.
Jennings, D. A.
Jarboe, Lt. C. W.
Jewell, T. E.
Jones, J. C.
Jones, Dr. Wm.
Jones, C. C.
Johnson & Bicknell.
Johnson, J. W.
Johnson, A.
Johnson, J. F.
Johnson, Wm. Neely.

Kaufman, Charles.
Keep, Mrs. A.
Keep, Col. Albert.
Keeler, Hon. J. M.
Keller, Alexander.
Kelley, Jay G.
Keeney, J. D.
Kelly, Wm. N.
Kelly, Alf. M.
Kelly, G. P.
Kendall, S.
Kennedy, James S.
Kesseler, J. & F.
Ketchum, A. A. P.
Keyes, W. S.
Klein, P. R.
Kidd, George W.
Kinney, Dr. Aug. C.
Kinney, George.
Kimble, George W.
Kirkpatrick, J.
Knapp, C. R.
Knight, L. F.
Knox, R. F.
Knox & Osborne.
Kuhl, H. G.
Kustel, G.
Kustel, Captain A.
Kruse & Euler.

Laine & Son.
Laine, Maurice.
Laine, Jules.
Laine, Manuel.
Lamont, F. A.
Lambing, J. P.
Law, G. W.
Lawver, Mr.
Landis, John.
Laws, Charles A.
Larson, A.
Lavelle, Mr.
Lauer, Mr.
Lansweert, L.
Leavitt, L.
Leary, John.
Lent, W. G.
Lent, Wm. M.
Levy, H. M.
Lent, Miss F. A.
Lee, Albert T.
Lee, Bruce.
Lewis, Wm. A.
Lewis, Sam. C.
Leavenworth, C. F.
Leechman, John.
Linton, W. D.
Litton, Capt.
Linkton, S.
Liversidge, Prof. A.
Lobree, Isaac.
Lombard, Thos. R.
Loomis, J. W.
Love, Miss Lily.
Love, H. P.
Lorquin, E. F.
Lofland, W. O.
Luckhardt, C. A.
Lyle, F. B.

McCormick, Hugh.
McCully, Thos.
McCurdy, J. C.
McDonald, Capt. J. M.
McDermot, C. V.
McDonough, T.
McDougal, W. C.
McGillevray, Mr.
McGrew, Wm. K.
McNeir, G.
McLaughlin, Mr.
McGraw, E. W.
McIntosh & Co.
McGoeghegan, Jno. T.
McMillan, J. H.
McQuesten, Dr. Chas.
McWorthy, T. J.
Mackay, Jno. W.
Mackay, P. N.
Mackillican, Wm.
Macomber, Henry S.
Madeira, Geo.
Manter, J. A.
Maize, H. B.
Mahoney, T.
Manning, J. G.
Manrow, J. P.
Manegault, G. E.
Maltby, Anson.
Masker, William.
Marvin, D. S.
Mason, W. B.
Marcus, Morris.
Marcou, Jules.
Martin, G. W.
Martin, E. W.
Mariotte, Noel.
Marion, G. F.
Maxwell, Dr. R. T.
Morrissey, Peter.
Maxwell, Jas.
Martin, Miss Kate.
May, Henry.
Marion, Sam.
Mayon, C. B.
May, Noel.
Maynard, H. G.
Matthews, Hon. J. H.
Mercantile Library Association.
Minister of Mines, B. C.
Merrill, C. R.
Merrill, F. H.
Metich, George.
Meves, Otto.
Miesegaes, A. D.
Minor, B. B.
Miller, C. S.
Mitchell, Charles.
Mitchell, H. K.
Mitchell, Hank.
Mills, David J.
Mills, Mrs. E.
Milles, C. L.
Mintzer, William H.
Mitchell, A. M.
Michael, G. W., Jr.
Minor, A. J.
Mitchell, G. W., Jr.
Miller, Henry.
Moore, William H.
Moore, L. A.
Mooklar, Dr. J. P.
Moody, William H.
Moraga, J. G.
Montgomery, William.
Morgan, D. W. C.
Morgan, Benjamin.
Morell, J. A.
Morales, A.
Morgan, Mrs. Ben.
Monteverde, F. E.
Mount Auburn G. M. Co.
Mosheimer, J.
Moss, Joshua.
Munroe, Professor Charles E.
Murphy, J. L.
Murdock, Captain G. L.
Murray, Welwood.
Murdock, W. B.
Muir, John A.
Murray, W. H.
Munzinger, Louis.
Musto Bros.
Myers, A.

New York and Dakota M'g Co.
Neale, John H.
Newman, Carlton.
Newsome, D. F.
Newton, Henry A.
Nichols, Charles B.
Nichols, George.
Norris, William.
Norris, Richard.
Norris, Smith.
Nougues, P. T.

Oakland Gold Mining Co.
O'Connor, Con.
O'Daly, John Ingham.
O'Keiffe, T. J.
O'Neil, Alexander.

Ogg, C.
Oliver, William L.
Onstott, J. H.
Orengo, B.
Oregon Iron Company.
Oregon Steam Navigation Co.
Osborn, H. E.
Osborn, Joseph.
Osborne, Thomas.
Owens, T. J.

Parker, Dr. W. C.
Palmer, J. C.
Parker, James E.
Parsons, S. M.
Pailhet, E. W.
Patterson, W. D.
Paul, A. B.
Perrin, R. J.
Perley, C. W.
Peterson, Gus.
Perkins, Phillip J.
Peticolas, C. L.
Peck, M. H.
Perkins, Henry C.
Pew, J. W.
Pittsburg Plate Glass Company.
Phillipin, John B.
Phillips, George.
Pilsbury, C. J.
Pownall, J. B.
Pope, O. C.
Porter, W. H.
Porter, David.
Price, Col. E. H.
Price, Edward M.
Pratt, W. M.
Putnam, Mr.
Purdy, Charles.
Purrington, C. P.
Pritchard, James A.

Quayle, William.
Queensland Museum.

Ramsay, Professor Alexander.
Randall, William H.
Raymond, W. H.
Raymond, A. S.
Randol, J. B.
Ralston, A. J.
Raynor, William.
Ralston, John.
Randolph, D. L.
Reagan, B. W.
Reed, Ira H.
Redway, J. W.
Redington & Co.
Redmond, J. H.
Redstone, A. E.
Rey, J. J.
Rhodes, John.
Ries, L.
Richards, Josiah H.
Rich, G.
Richards, William H.
Robinson, Tod.
Roberts, George D.
Rogers, R. H.
Roderick, Frank.
Roberts, E. W.
Robertson, Ella.
Robinson, C. P.
Roby, F. M.
Roberts, A. E.
Robinson, L. L.
Rosecrans, General.
Ross, C. L.
Rowley, A. B.
Rupert, J. A.
Ruffino, S.
Russell, B. D.
Russell, David.
Ryan, J. F.
Ryan, Matthew.

Salamander Felting Company.
Salisbury & Palen.
San Bernardino Borax Co.
Sanford, J. L.
Sarvis, George C.
Schneider, C. J.
Schaeffle, E. H.
Scott, Chalmers.
Schultz, George.
Schuyler, W. S.
Schneider, C.
Schlageter, F.
Schofield, General J. M.
Schofield & Tevis.
Schmidt, William.
Schenck, George H.
Schuyler, James D.
Scupham, J. R.
Scupham & Childs.
Scupham & Bullock.
Sears, William H.
Sellers, Charles.
Selby, Prentiss.
Selby Lead and Smelting Co.
Secretary Gt. Republic Mg. Co.
Sheldon, N. P.
Shepard, Prof. C. W.
San Francisco Journal of Commerce.
Sherwood, Henry.
Sherman, Chas. E.
Sheerer, Jos.
Shuster, F. O.
Shimmin, E. R.
Sherburne, J. S.
Shilling, J. S.
Shaw, S. W.
Sifers, A.
Simpson, W. H.
Sinton, R. H.
Sine, Wm. K.
Simondi, A. L.
Simkins, C. H.
Sierra Iron Co.
Silver, Lowry.
Skillings, E. M.
Skinner, Robt.
Skinner, M.
Skinker, John.
Sleeper, W. O.
Sleeper, T. P.
Sletcher, F.
Slocum, Mrs. Chas.
Smith, Mrs. F. E.
Smith, E. B.
Smith, E. M.
Smith, F. M.
Smith, F. E.
Smith, J. T.
Smith, F. W.
Smith Bros.
Soto, M. A.
Sommer, Ad.
Spencer, J. W.
Spaulding, Geo.
Spaulding, John.
Spencer, E. G.
Speckerman, Wm.
Squire, Miss A. M.
Stambaugh, S. S.
Staples, F. H.
Stanley, W. H.
Steel, T.
Stateler, J. W., Jr.
Stegman, W. G.
Stewart, Hon. W. M.
Sternberg, Dr. Geo. M.
Steinhagen, P.
Stone, Geo. W.
Stone, D. L.
Stone, D. C.
Stone, Chas. S.
Stokes, W. C.
Stoutenborough, J. H.
Strong, Mr.
Strother, E.
Sublette, Wm.
Suffern, J. A.
Swan, T. M.
Swan, G. W.
Sweet, S. S.
Sweet, C.
Swearingen, S. E.
Szabo, Dr. Joseph.

Tanner, Mrs. J. G.
Tarpy, D. P.
Taylor, J. M.
Taglibue, Frank.
Temescal Tin Co.
Thayer, B. B.
Thibodo, Dr. A. J.
Thrall, H. H.
Thorpe, Col. W.
Thorn, I. N.
Thrift, A. M.
Thomas, R. B.
Thornton, H. J.
Toomey, M.
Townsend, Mrs.
Townsend, W. R.
Tranger, J. H.
Trask, J. L.
Trask, Dr. J. B.
Traylor, W. W.
Treadwell, J. B.
Truitt, M. F.
Tryel, Mr.
Tubbs, Hiram
Tutt, Barney.
Tuttle, P. G.
Tuck, J. H. L.
Tyler, Charles M.

Utter, George W.
Utter, F.
Union Pacific Salt Co.

Vassault, F.
Verdenal, D. F.
Ventura Rock Soap Co.
Vincent, George A.
Von Lindner, M. F.

Vosburgh, J. J.

Walkinshaw, Robert.
Walsh, Judge James.
Wand, T. N.
Ward, Prof. Henry A.
Ward, H. H.
Ward, W. E.
Wagoner, Luther.
Waller, T. P. F.
Watson, William H.
Wagner, Joseph.
Walker, Dr. D.
Watson, E. H.
Wallace, Thomas.
Wasson, Hon. Jos.
Waterman, J. S.
Wayson, James.
Webb, A. T.
Wellin, P. M.
Wegener, B.
Wellendorf, L.
Weir, James C.
West, D. W.
Wheeler, M. A.
Whittier, Fuller & Co.
Whisby, L. N.
White, D. Morgan.
White, Mrs. J. S.
Whitman, S.
Wilson, J. Downes.
Wilcox, A. O.
Wilcox, J. W.
Winder, W. A.
Williams, F.
Winall, Mrs. M. A.
Winall, S. A.
Williams, G. F.
Williams, Colonel A. F.
Wilson, W. H.
Wilson, J. F.
Wight, Captain J. N.
Wilkinson, Jos.
Williamson, Colonel R. S.
Williams & Blanchard.
Wilson, George R.
Winans, J. C.
Wightman Bros.
Wilkinson, J. W.
Winterburn, John
Woodbury, J. G.
Woodhull, S. D.
Woodward, R. B.
Woodward, E. W.
Wolverton, J. R.
Wolleb, E.
Woodley, W. J.
Worcester Royal Porcelain W'ks
Wright, Alfred.
Wright, J. E.
Wyman, G. D.
Wynants, N.

Yale, Charles G.
Young, J. W., Jr.
Young, William W.

Zuber, G. L.

STATEMENT OF RECEIPTS AND DISBURSEMENTS, STATE MINING BUREAU.

From May 15, 1880, *to May* 15, 1884, *inclusive.*

RECEIPTS.			
Bureau Fund			$25,972 44
Advances by Wells, Fargo & Co.			3,968 73
Warrants for State Mineralogist's salary			12,000 00
DISBURSEMENTS.			
Expenses:			
Rent	$8,675 00		
Safe	325 00		
General expenses	5,934 21		
		14,934 21	
Salaries:			
Secretary	$4,660 00		
Janitor	2,215 00		
Compilers and writers	710 00		
Chemist	1,125 00		
Copyists	127 50		
Museum attendance	123 70		
Labor	7 75		
		8,968 95	
Salary State Mineralogist		12,000 00	
Postage		224 75	
Museum		3,608 39	
Maps		160 35	
Library		345 00	
Traveling expenses		487 65	
Interest		1,130 65	
Cash on hand		81 22	
		$41,941 17	$41,941 17

SAN FRANCISCO, June 1, 1884.

I hereby certify that I have made a thorough examination of the books of the State Mining Bureau from May 15, 1880, to May 15, 1884, inclusive, and found the same to be correct.

EDWIN BONNELL, Accountant.

CHEMICAL WORK.

There is but little to report for this department. Since the discontinuance of laboratory work, and discharge of the efficient chemist—for want of funds—but little chemical work has been attempted beyond the examination of many minerals which have been sent in. This work has generally been done at odd times, mostly at night. The following is a record of analyses of minerals, etc., which are entered in the catalogue. The State Mining Bureau should be provided with a first-class chemical and metallurgical laboratory, and with funds to use in the employment of assistants, who should be engaged continually in the analysis of California minerals, ores, rocks, mineral waters, building stones, etc., and the results published annually as part of the report of the State Mineralogist. The want of a laboratory is daily realized. A chemical laboratory and library of reference should be considered the foundation of an institution such as the Mining Bureau was intended to be, and it will be impossible to make the institution worthy of the name without them.

ORE ASSAYS.

2034. Pyrite, containing gold and silver:

Gold, per ton	$51 00
Silver, per ton	222 00
	$273 00

3358. Copper Ore, Pioneer Mine, Bolinas Bay, Marin County:

Silver, per ton	$22 00
Gold	Trace
Copper	11 per cent

MINERAL ANALYSES.

1939. White Marble, Section 15, Township 13 north, Range 8 east, M. D. M., Placer County, California. This marble has been used in San Francisco for the generation of carbonic acid in the manufacture of artificial mineral waters:

Silica	.15
Sesquioxide of iron	.35
Lime	55.72
Carbonic acid	43.78
	100.00

2035. Cement rock, Washington Corners, Alameda County, California:

Silica	.05
Sesquioxide of iron	.16
Carbonate of magnesia	.65
Carbonate of lime	99.14
	100.00

2036. Arquerite—Silver amalgam, Vital Creek, British Columbia, latitude 53° north:

Mercury	11.90
Silver	86.15
Silica	.45
	98.50

2404. Stalactites (?) deposited by jets of steam at the Mud Volcanoes, Township 11 south, Range 13 east, San Diego County, California. Qualitative analysis shows carbonate of lime, with silica, iron, alumina, and magnesia, sulphuric acid in small quantities, and considerable common salt.

2443. Incrustation, Mud Volcanoes, Township 11 south, Range 13 east, San Bernardino Meridian, Colorado Desert, San Diego County, California:

Water	2.35
Chloride of sodium	1.26
Sesquioxide of iron	2.16
Sulphate of lime	1.79
Carbonate of lime	78.10
Carbonate of magnesia	2.84
Silica, clay, etc.	9.97
	98.47

1675. Concentrations from hydraulic washings, Jackson, Amador County, California—mechanical analysis:

Portion A—Coarse non-magnetic	56.6
Portion B—Fine non-magnetic	18.4
Portion C—Magnetic	25.0
	100.0

A—Contains garnets, sulphides of iron, various dark colored grains, and striated mineral, which, under the microscope, resembles selenite.

B—Is principally quartz sand. There are some amorphous particles of a red color, and the mineral resembling selenite.

C—Is almost entirely magnetite.

5213. Mechanical analysis of auriferous gravel, from Nevada hydraulic mine, Chalk Bluffs, Nevada County, California. (See Second Annual Report, 1882, folio 97):

	Per Cent.	Per Ct. Quartz.
Portion "A," zircon sand	00.01	------
Portion "B," large pebbles	39.80	89
Portion "C," coarse gravel	29.80	63
Portion "D," remained on No. 10 sieve	7.67	57
Portion "E," remained on No. 20 sieve	1.03	59
Portion "F," remained on No. 40 sieve	3.13	78
Portion "G," remained on No. 60 sieve	3.90	86
Portion "H," remained on No. 80 sieve	1.53	80
Portion "K," remained on No. 100 sieve	1.37	82
Portion "L," passed No. 100 sieve	1.47	72
Portion "M," slickens	10.29	N'ly all.
	100.00	

1883. Indurated Clay, corner of Filbert and Leavenworth Streets, San Francisco:

Silica	56.51
Alumina	21.33
Sesquioxide of iron	12.31
Lime	3.53
Water	6.30
Magnesia	Trace.
	99.98

1944. Clay, near Lincoln, Placer County, California. Called by the potters, blue plastic clay:

Silica	44.82
Alumina	34.54
Combined water	8.37
Hygroscopic water	1.27
Carbonate of lime	3.00
Magnesia	.96
Soda	4.74
Sesquioxide of iron	1.86
Loss	.44
	100.00

1945. Clay, near Lincoln, Placer County. Called by the potters, white non-plastic clay:

Silica	41.80
Alumina	38.78
Combined water	6.00
Hygroscopic water	1.62
Carbonate of lime	2.64
Magnesia	1.02
Soda	3.46
Sesquioxide of iron	2.12
Loss	2.56
	100.00

ANALYSES OF CALIFORNIA IRON ORES.

Catalogue Number.	Location.	Mineral Character.	Silica.	Ferrous Oxide.	Ferric Oxide.	Water.	Lime.	Sulphur.	Phosphorus.	Total.	Per Cent of Metallic Iron.
1761	Potters' Iron Mine, Shasta County	Magnetite	.49	19.59	79.90	----	----	----	----	99.98	71.16
1937	Red Hill, Placer County	Limonite	33.10	----	55.25	9.35	1.65	Trace.	Trace.	99.35	38.68
1938	California Iron Co., Placer County	Magnetite	3.23	17.06	80.05	----	----	----	----	100.34	69.29
1996	Coulterville, Mariposa County	Magnetite	15.50	7.39	77.78	----	----	Trace.	----	100.67	59.72
2274	Coast Range, San Benito County	Magnetite	14.70	18.72	65.40	.15	----	Trace.	----	98.97	59.74
4148	Near Latrobe, El Dorado County	Limonite	6.51	0.80	78.27	14.75	----	.57	.02	100.92	55.41
1861	Clipper Gap, Placer County	Ocherous Limonite	5.70	----	79.90	14.90	----	Trace.	Trace.	100.50	55.93
----	Clipper Gap, Placer County	Limonite	9.28	----	76.97	13.70	----	Trace.	----	99.95	53.88
----	Clipper Gap, Placer County	Limonite	7.16	----	80.83	11.80	----	Trace.	Trace.	99.79	56.58
----	Placer County	Magnetite	3.23	17.06	80.05	----	----	----	----	100.34	68.28

APPROXIMATE ANALYSES OF LIGNITES FOUND IN CALIFORNIA.

Catalogue Number.	Location.	Fixed Carbon.	Volatile Combustible Matter.	Water.	Ash.	Total.	Available Fuel.	Waste.
1800	Cienega del Gabilan Rancho, San Benito County	30.00	31.15	18.40	20.45	100	61.15	38.85
2334	Santa Clara Coal Mine, Los Angeles County	49.53	29.93	7.87	12.67	100	79.46	20.54
2378	Cajon Pass, San Bernardino County	46.53	27.67	9.67	16.13	100	74.20	25.80
2379	Telegraph Hill, San Francisco	16.50	----	1.30	82.20	100	16.50	83.50
2513	Near Bieber, Lassen County	9.87	11.40	20.40	58.33	100	21.27	78.73
2533	Tejon Pass, Kern County	44.86	34.60	10.47	10.07	100	79.46	20.54
2910	Panoche Pass	31.54	31.73	13.73	23.00	100	63.27	36.73
4096	Near Lexington, Santa Clara County	47.00	29.50	16.50	7.00	100	76.50	23.50
4755	Near Mount Diablo, Contra Costa County	17.60	24.40 Including water.	----	58.00	100	----	----
5045	Temescal Mountains, twenty-five miles southwest of Colton, San Bernardino County	27.74	32.26	20.00	20.00	100	60.00	40.00
5187	Willits, Mendocino County	41.75	19.00 Including water.	----	39.25	100	----	----

PACIFIC COAST MINERAL EXPOSITION OF AUGUST, 1883.

This first attempt to represent the bountiful mineral resources of California in particular, and the Pacific Coast in general, was the result of the citizens' meeting of March 26, 1883, called by the State Mineralogist to take into consideration the future of the State Museum. While the meeting did not accomplish directly the end for which it was called, it resulted in good to the State and added largely to the collections in the Museum.

The preliminary steps taken by the committees are recorded in the Third Annual Report. The occasion of the Mineral Exposition was the meeting at San Francisco of the Triennial Conclave of Knights Templar of the United States. It was considered that intelligent representatives from every part of the Union would meet in San Francisco, and would expect to be shown the natural resources of the State, and that many persons not connected with the Order would visit California at the same time, making the occasion one of special fitness.

In response to circulars, many specimens were sent to the Museum, some as donations, others as loans. Several counties appropriated money to furnish special cases in which to display county specimens. To enable the management to arrange the exhibits, the Museum was closed to the public for a few weeks. The exposition was formally opened on the morning of August 15, 1883. Lieutenant-Governor John Daggett addressed those who were present as to the value of the exposition. He enlarged on the extraordinary mineral wealth of California, and the importance of making it known to the world, and the fitting occasion afforded by the meeting of the Triennial Conclave. Then, on behalf of the State, he declared the exposition open, and delivered the special exhibits into the charge of the State Mineralogist.

Besides the large collections of the State Mining Bureau arranged and in cases, all the specimens in process of classification were provided with temporary written labels and placed on tables and in twenty-four cases hired for the occasion. The exhibition attracted much attention, and was largely visited both by citizens and strangers.

Italian Collection. This collection has been acquired by exchange and by purchase. It fills four cases, and consists of minerals, ores, rocks, including ancient and modern marbles, fossils, etc. The Italian citizens of San Francisco evinced considerable interest in this collection, and added to it by loaning a fine Italian flag and photographs of ancient buildings in Rome.

Part of the Honduras collection, consisting of antiquities, woods, etc., was left by President Soto during the Exposition. The antiquities have since been removed, but duplicate samples of the woods were donated, and form an attractive feature in the State Museum.

On application, the Chief of Police detailed two officers, W. J. Shaw and G. W. Curtis, who remained in charge night and day during the Exposition. Nothing was lost or stolen.

John Meelen loaned a large American flag, which was hung in the Museum.

The following counties furnished money to purchase special county cases in which to exhibit the mineral resources of each: Butte, 2 cases; Inyo, 2 cases; Mono, 2 cases; San Bernardino, 2 cases; Tuolumne, 1 case; Humboldt, 1 case; Calaveras County sent the money for 2 cases, which, through a mistake, did not reach the management until after the Exposition closed.

The following list of the most important special exhibits, gives also the names of those who made them:

Adams and Carter. Frue concentrator. The whole apparatus was set up in the Museum. The apparatus is for the concentration of "slimes," and finely crushed material; for treatment of gold and silver mill tailings, and direct concentration of ores of silver, lead, copper, tin, zinc, etc., after stamps or pulverizers. It is automatic, and requires but little power or attention. Nearly 600 are now in use, manufactured in San Francisco.

M. P. Boss. Two highly finished mechanical drawings, designed by him and executed by *D. J. Osborne.* One showing the details of the Boss continuous system of pan amalgamation. The second a side elevation of the same. This process was first introduced into the Noonday mill at Bodie, Mono County, in May, 1880.

A. C. Bowen. Crystals of gold. Banner mine, near Michigan Bluffs, Placer County. Two pieces, the largest of which was a paneled octahedron, weighing 30.6 grams, one of the finest ever found in the State. The smaller was a flat piece covered with small octahedral crystals. Loan.

A. L. Burbridge. Three large specimens of silver ore, coated with embolite. Etna mine, Globe District, Pinal County, Arizona. Loan.

William Cameron. Ores containing free gold, with pyrite. Hidden Treasure mine, Placer County.

J. H. Carmany. Free gold in porphyry, associated with pyrolusite. Banghart mine, Shasta County, California. Magnificent specimen. Loan. Gold specimens. Mad Ox mine, near Washington, Shasta County, California. Loan.

John Daniel. Granite vase, from Lee's quarry, Placer County, California. Loan.

J. Z. Davis. Four cases containing specimens from his private collection, selected for their beauty, rarity, and interest. Also, many curiosities of great interest from his private collection. The exhibit was one that attracted much attention, and although entered as a loan, it still remains in the Museum. Gold watch, made in Dublin 120 years ago. Loan.

N. Dodge. Placer gold of unusual shape. Also, wire silver and gold in quartz. Loan.

W. E. Duncan. Specimens of gold quartz. Butte County, California. Loan.

Mrs. M. Durden. California woods, and an oil painting of Sutter's Mill, El Dorado County, the locality at which gold was first discovered. Loan.

Thomas Ewing. Providence Mountain, San Bernardino County. One case of rich silver ores from the mines which he is now successfully working. Ores, Belle McGillivray mine; suite of typical specimens. Providence Mountain. Ores from Bonanza King. Bonanza King Consolidated Mining Company, of New York. Providence Mountain. A full suite of very rich specimens from all the workings. All the specimens and the case containing them were donated by Mr. Ewing.

N. C. Fassett, Superintendent. Silver ores from the Belmont mine, Belmont, Nevada. Assay value, $4,000 per ton. Loan.

Louis Glass, Cherokee, Butte County. Specimens representing hydraulic mining at Cherokee. Blue gravel, bottom stratum, 6 to 10 feet thick. Yellow or rotten bowlders, from 1 to 10 feet thick, rich in gold, overlying blue gravel. White top gravel, 20 to 400 feet thick, overlying rotten bowlders. Basalt capping overlying white top gravel. Donation. Specimens of hydraulic gold, from large nuggets to the finest of placer gold. Loan. Gold amalgam, before retorting. Loan. Gold amalgam, after retorting, called retorted amalgam. Loan. Diamondiferous sand or gravel. Platinum found with gold in cleaning up. Donation. Placer gold and black sand clean up. Loan. Diamonds, cut and uncut, found in the mine from time to time—very interesting specimens. Loan.

A. J. Howth. Thinolite. Mono Lake. A fine specimen. Contributed.

Hunt and Chace. Harris dry gold separator. The complete machine was on exhibition. It is so constructed that it can readily be taken apart and packed in small space. The machine is turned by hand. Two currents of air are produced, while the dry material is agitated; one assists in the agitation, the other carries off the lighter particles. Capacity claimed is 20 to 30 tons per day, and the cost of the machine is $150 to $250.

D. B. James. Full-sized mining car for use in tunnels, drifts, etc. Loan.

Josiah Keep, Alameda, California. California shells and a book published by him on conchology. Loan. The shells were principally from Monterey Bay, but also from other localities. The work, "Common Sea Shells of California," contains 16 plates, illustrating about 100 California species, from drawings made from nature.

Marcus Laville. Plumbago, Tuolumne County.

John Leechman. Placer gold, Cave Diggings; Sections 28 and 29, Township 1 north, Range 16 east, Tuolumne County, California; in Limestone belt. Loan. A full suite of the ores and wall rock of the Soulsby mine, Tuolumne County. Donation.

W. N. Martin. Very fine specimens of free gold in quartz, from the New El Dorado gold mine, Greenwood Township, El Dorado County, California, formerly known as the North Cederberg. Loan.

Alvin Mathis. One case private collection, consisting principally of specimens from California quicksilver mines. Sixty-four fine specimens, many beautifully crystallized. Loan.

B. B. Miner. Gold specimen. Fine Gold Gulch, thirty miles east of Madera, Fresno County, California.

F. E. Monteverde. Rare and beautiful specimens, as follows. Loaned: Gold in calcite, Calaveras County. Gold crystals, Calaveras County. Gold crystals, White Bull mine, Linn County, Oregon.

Joseph L. Moody. Special case of very rich gold specimens from the Four Hills gold mine, Sierra County, California. Loan.

This was a remarkable exhibit, the value of the gold in the specimens was estimated at $10,000. In some there was more gold than quartz in all a striking illustration of the richness of some of the gold mines of California.

W. D. Minckler. Susanville, Lassen County. A collection of interesting specimens. Donated. Pebbles from Pyramid Lake shore. Red obsidian; tourmaline in quartz; jasper in several varieties; arrowheads, etc.

H. H. Noble. Large and magnificent specimen of silver ore, with much native silver, and crystals of polybasite. Silver King mine, Pinal County, Arizona. Loaned. Also fine specimens crystallized native silver, same mine.

A. B. Paul. Placer gold. Red Hill hydraulic mine, Butte County, California. Loaned. Masonic lambskin apron, worn by Masons one hundred years ago. Loan. Placer gold, west branch of Feather River, Butte County, California. Loan. Relics, objects, and manuscripts, bearing on the early history of the Comstock silver lode, Nevada, framed and glazed; a very interesting collection. Loan.

L. Radovich. Two cases ores and minerals, and fine specimen native silver, from Nevada. Also, working model of rock-breaker. Loan.

J. B. Randol. Specimen of cinnabar weighing 290 pounds, nearly pure, from New Almaden Quicksilver Mine, Santa Clara County. Donation.

Large iron dish filled with metallic mercury (quicksilver), New Almaden mine. Loan. This exhibit attracted special attention. A large iron bolt weighing several pounds floated on the surface of the liquid metal. Hundreds, if not thousands, of visitors thrust their hands beneath the surface. Ladies with gloved hands caught the infection, and could not be restrained from lifting handfuls of the bright metal, and allowing it to run in silver streams between their fingers. Some would remove their gloves, and, although warned of the effect, would plunge their ringed hands beneath the surface, and were surprised on removing them to find that their gold rings had turned white from amalgamation with the mercury.

I. I. Rapp. Gold in quartz. "Our Flag" mine, Carson Hill district, Calaveras County. Loan.

Nathan Rhine. Very rich specimen of gold quartz from the Keynot mine, Beveridge District, Inyo County, California, in elegant case. Loan.

S. Ruffino. Ten specimens ores, various, from West Point, Calaveras County, California.

E. F. Russell and *E. F. Barber.* Specimens of steel made from black sands of California: 1. Specimen black sand steel produced by the Russell process, hammered, also welded three times, and ground off to show the weld. Loan. 2. Cold-chisels from black sand steel, and iron cut by the same. 3. Steel wire from the same. 4. Specimens of the sand from which the steel was made.

Geo. E. Schenk. Poor Richard Almanac, 1773; Maryland and Baltimore Journal and Advertiser, August 20, 1772; Autograph letter from Dr. Benjamin Franklin to James Searle, Amsterdam, dated Passy, France, November 30, 1780. Copy of Patrick Henry's speech, July 4, 1776. Loan.

Colonel R. B. Stockton. Ore rich in free gold, and sulphurets. Stockton mine, near Madera, Fresno County, California.

J. P. Stanley. Santa Rosa. Two large cases filled with fine specimens of minerals, ores, rocks, fossils, etc., with ethnological specimens of great interest. Loan. A private collection gathered during many years of residence in California. The collection contained specimens from other countries, as well as California. The cases attracted much attention.

Mrs. H. F. Thomson. Four specimens gold-bearing quartz and one specimen copper sulphurets. Bully Choop, Trinity County, California.

W. J. Tustin. Tustin's rotary pulverizing mill represented by elaborate drawings.

J. D. Walker. Calaveras County. Irish copper coin. Loan.

H. W. Walker. Improved cupel mold. It has a convex edge to the bowl, which allows the mold to clear itself. The plunger does not require cleaning. From 10 to 12 dozen can be made in an hour. Samples of the cupels also were exhibited.

Ward and Blackwell. Placer gold from their deep gravel mine, Snow Point, Nevada County, California. Very coarse gold and nuggets. Loan.

Mrs. William Watts. Specimens of silicified wood, very fine. Iowa Hill, Placer County, California.

S. D. Woodhull. Independence. Three cases of minerals, ores, etc., from Inyo County, California, being his private collection made during a number of years' residence in that very interesting locality. Loan. This was a very attractive and instructive exhibit, showing at a glance the wonderful mineral resources of Inyo County.

——— Five specimens of gold, with cinnabar, from the Manzanita mine, Sulphur Creek, Colusa County, California. Loan.

STATEMENT OF RECEIPTS AND DISBURSEMENTS.

Citizens' Committee, Pacific Coast Mineral Exposition.

1883.	RECEIPTS.	
June 14	—Butte County, by Louis Glass	$100 00
20	—Boyd & Davis, Thurlow Block	250 00
24	—J. M. McDonald, Pacific Bank	50 00
	Joshua Hendy, Mission and Fremont Streets	5 00
	Geo. Schmidt, Fountain Saloon	5 00
	Inyo County	100 00
	Mono County	100 00
	San Bernardino	50 00
	Tuolumne County	50 00
Aug. 16	—Collected by S. Hydenfeldt, Jr.	25 00
	Citizens of Patterson District, Mono County, collected by M. Jones, as follows:	
	Dr. G. M. Summers	5 00
	Martin Jones	1 00
	M. A. Herne	1 50
	Chas. Dupee	1 00
	E. D. Ebi	1 00
	Henry Williams	1 00
	James Garaway	1 00
	Geo. Kinney	1 00
	B. S. Brown	1 00
	D. R. Avery, Center Market	5 00
	D. A. Terry, Center Market	2 50
Oct. 25	—Humboldt County	50 00
	Advanced by J. Z. Davis	19 85
		$825 85

1883.	DISBURSEMENTS.	
July 12	—Postage stamps	$3 00
20	—Glass dishes	40
	Glass dishes	45
	Freight	1 70
21	—Freight, Mono County	4 75
22	—Labor, carrying large specimen of cinnabar upstairs	50
24	—Cartage on mine model	1 25
26	—Freight from Bodie	7 50
	Freight, Stanley collection	2 25
28	—Delivering notices and papers	25
	Expenses on cases	1 45
Aug. 9	—Freight on case from Humboldt	3 40
Sept. 1	—Cherry & Johnson, bill of painting	26 00
	Cartage on Silver King specimen	50
Aug. 18	—Daily Exchange, advertising	7 50
July 28	—Wm. Proll, making 13 cases	494 00
May 1	—Bacon & Co., printing	43 25
7	—Wm. Proll, cases and tables	106 15
	Robinson & Gilespie, carpenters	64 05
Oct. 27	—Wm. Proll, Humboldt County case	40 00
	Sundry small expenses	17 50
		$825 85

HISTORY OF THE GEOLOGICAL SURVEYS OF THE STATE.

The United States Exploring Expedition, under command of Captain Charles Wilkes, 1838-39-40-41-42, visited California and Oregon. James D. Dana was Geologist, and his observations are given in the reports.

Duflot de Mofras explored Oregon, California, and the Vermilion Sea during the years 1840-41-42. His report was published in Paris in 1844.

John C. Fremont explored Oregon and California in 1843 and 1844. The geology and palæontology were worked up by James Hall, of New York, and published in appendix to report of 1845.

Bayard Taylor came to California in 1849. A report of his observations appears in "El Dorado, or Adventures in the Path of Empire," New York, 1850. In the appendix report to Hon. T. Butler King, the metallic and mineral wealth of the State are considered.

The first writing on the geology of California after the discovery of gold, seems to have been a short report to the Secretary of War on the geology and topography of California by Philip T. Tyson. (Ex. Doc. No. 47 to the Senate of the Thirty-first Congress.) Manifee & Co., of Baltimore, published a reprint of this report in 1851. He examined the country from Benicia to the American and Calaveras Rivers in 1849, during the delirium of the gold fever. Mr. Tyson came to California with T. Butler King, who was sent out by the United States Government, on the discovery of gold being made known.

James S. Wilson, a practical gold miner, published a paper on the same subject, in the Quarterly Journal of the Geological Society of London about the same time.

The United States Government sent out an expedition to explore for a route for a railroad from the Mississippi River to the Pacific Ocean, under the orders of the War Department, in 1853-54. Of the reports, generally known as the Pacific Railroad Reports, twelve large volumes were published. One of the expeditions planned by the Government to explore the newly acquired western possessions of the American Union, and to determine the most practicable railway route from the Mississippi River to the Pacific Ocean, was organized for California, to explore the Sierra Nevada from Walker's Pass southward to the boundary, to ascertain the best and available mountain passes. This was placed under the command of Lieutenant R. S. Williams, Topographical Engineers, with J. G. Parke second in command, and through the recommendation of the Smithsonian Institution, Mr. W. P. Blake, a graduate of the Scientific Department of Yale, was appointed Mineralogist and Geologist. The party left Benicia Barracks early in the Summer of 1853, and made a continuous reconnaissance to the Tejon and Walker's Pass, passing through Livermore's Valley, the San Joaquin Valley, the Tulares, and following as near as possible to the foothills of the Sierra Nevada.

Detailed surveys were made of several of the passes and the adjacent country. The topography of that region was first ascertained, and for the first time delineated upon any map. The geology was determined and mapped also, and the first geological section of the Sierra Nevada was drawn. The explorations were extended southward along the mountains to San Bernardino, and to the boundary line. Amongst other results may be mentioned the discovery of eocene and miocene tertiary beds, and the determination of the ancient lacustrine formation of the Tulare Valley, and of the valley of the Colorado Desert. The barometrical observations from San Bernardino to Camp Yuma on the Colorado, were taken by Mr. Blake, and he announced the fact that an extensive area of the desert was below the sea-level, a conclusion that the commander of the expedition was reluctant to admit.

The results of the season's work, and of operations made in the gold region in the year 1854, were embodied in a report to the United States Government, and were finally published in a quarto volume, entitled: Report of a Geological Reconnoissance in California, etc.; by William P. Blake; published in the series of quarto reports on the explorations of the routes for a railway to the Pacific, and separately by the author; New York, 1858, pp. xviii+370+xiii, with plates of fossils, geological sections, and a geological map of California.

An article on the extent and geology of the gold region was also contributed to the American Journal of Science, and during a subsequent residence in California in 1860–1867, and the occupation of a Professor's chair in the College of California, several articles were contributed to the California Academy of Sciences. Professor Blake, in his first report, gave the first notice and sketches of the High Sierra, as seen from the Four Creeks, directing attention to the great altitude of the peaks, and to the peculiar serrated outline of the range in that region.

Professor Blake was appointed the Geologist of the State Board of Agriculture in 1866, and made a report on the minerals of the State.

Annotated Catalogue of the Principal Mineral Species hitherto recognized in California and the adjoining States and Territories, March, 1866. 8vo., pp. 32.

The secondary age of a part at least, of the gold-bearing rocks of California, was discovered and announced in 1863 and 1864, by Professor Blake. *Proc. Acad. Nat. Sci. Cal., Oct. 3, 1864.*

On the fifth day of March, 1853, the California State Legislature passed a joint resolution, calling on Doctor John B. Trask for such information as he might possess, relative to the geology of the State, the result of which was a "report on the geology of the Sierra Nevada, or the California Range," thirty-one pages, of which two thousand copies were ordered printed. On the sixth day of May, of the same year, a joint resolution was passed authorizing further geological examination of some parts of the Sierra Nevada and coast mountains, and providing that a report of the results should be presented to the next Legislature. Doctor John B. Trask was appointed first State Geologist.. The second report by Doctor Trask contained ninety-five pages, entitled "report on the geology of the coast mountains, and part of the Sierra Nevada, embracing their industrial resources in agriculture and mining," and was presented to the Assembly, session of 1854, John Bigler, Governor.

Jules Marcou, a French Geologist, visited California in 1854, an account of which he published in the Bibliotheqúe Universal de Genéve in 1855.

The third report of the State Geologist, entitled, "report on the geology of the coast mountains, embracing agricultural and mineral productions; also portions of the middle and northern mining districts," ninety-two pages, was presented to the Assembly, session of 1855; John Bigler, Governor; John B. Trask, State Geologist.

The fourth report was made to the Assembly, session of 1856, and was entitled, "report on the geology of Northern and Southern California, embracing the mineral and agricultural resources of those sections, with statistics of the northern, southern, and middle mines;" J. Neely Johnson, Governor; John B. Trask, State Geologist.

In 1860 an Act of the Legislature, approved April twenty-first by John G. Downey, Governor, was passed entitled "An Act to create the office of State Geologist, and to define the duties thereof." Section one appointed J. D. Whitney State Geologist, to make with assistants an accurate and complete geological survey of the State, to describe in reports and maps the rocks, fossils, soils, minerals, botanical and zoölogical productions, and to collect specimens to be deposited in some place to be provided by the Legislature. Section four provided that the reports should be sold to the best advantage, and the moneys derived from the sale to be placed in the Common School Fund of the State. Section eight set apart $20,000 out of any money not otherwise appropriated, as a special fund for payment of expenses incurred by the survey.

W. H. Brewer and William Ashburner came to the State with Professor Whitney, and arrived November 14, 1860.

Mr. C. F. Hoffman joined the survey March 20, 1861, and commenced work as a topographical assistant.

July 1, 1861, Dr. J. G. Cooper was appointed zoölogist of the survey.

Early in 1862 W. M. Gabb arrived in California, and became palæontologist of the survey.

A. Rémond became a volunteer assistant in 1862, and continued with the survey until the end of 1863.

V. Wackenreuder held the position of topographical assistant during 1862 and 1863.

In 1863 Clarence King joined the survey as volunteer assistant in the geological field work.

In 1864 J. T. Gardner was volunteer assistant in topographical field work.

The appropriation from the commencement in April, 1860, to April, 1864, was $70,000.

In 1864 a second Act of the Legislature was passed reappointing Professor J. D. Whitney State Geologist, approved April fourth, by Frederick F. Low, Governor.

In 1864 the first volume of Palæontology was published, and in 1865 the volume on General Geology.

H. N. Bolander was connected with the survey in 1866 in the department of botany.

In 1869, volume two Palæontology was published.

In 1870, the Yosemite Guide Book and volume one Ornithology were published.

The Legislature of 1873–74 declined to make further appropriations, which of course discontinued the survey.

The State Geological Survey, so well and ably conducted by Professor Whitney and his staff of efficient assistants, was and is a great credit to California, and is so judged by those competent to express an opinion, the world over. Its abrupt termination was a misfortune not only to California but to the world, and a lamentable mistake. The ability of Professor Whitney, and his industry and integrity, have never been questioned even by those who differed in opinion as to the manner of his work. The censure implied by the discontinuance of the survey was an injustice to him. The only objection ever made was, that his work was not practical in the sense intended by the Act of Legislature which created the survey. Did the Legislature fully realize the following considerations? When Professor Whitney was appointed State Geologist, California was almost a *terra incognita*, in a geological sense; the surveys of Dr. Trask and those of the Pacific Railroad Engineers sent out by the Government, and the researches of the California Academy of Sciences lifted the margin of the vail which had hidden the geology of California from the world, and a glimpse only had been obtained of the mineral wealth of the State; the Government land surveys had not been completed; there were no railroads; hostile bands of Indians defended the mountain passes against prospector and surveyor alike; the area of the State was greater than that of any other in the Union except Texas, one hundred and twenty times as great as Rhode Island, three and one third times that of New York, and twenty times that of Massachusetts; there were snowy and almost inaccessible mountains and burning deserts to cross. These difficulties had to be surmounted. Since those days things have changed. The whole country is to a certain extent prospected; good mountain roads have been built on which lines of stages run daily; the most distant parts of the State are accessible by railroads; the cost of labor and necessities has diminished; the results of pioneer surveys have been tabulated and put into available form. Still, geology and mining in California are as yet in their infancy. Many, many years must elapse before we shall fully understand the geology and realize the magnitude of the mineral deposits within the area which we now call the State of California.

The foundation, so well laid by the State Geological Survey, will serve to build all future and more detailed surveys upon. The reports and maps of the survey, and the great State map, made by the present State Engineer, must for all time be the base for future surveys, be they geological, geographical, or agricultural. All we can do, will be to broaden the foundation already laid, leaving the completion of the superstructure to those who will follow.

Immediate practical results should not be expected, except to a limited extent, but the vast field presented, and the magnitude of the work undertaken, duly considered.

The Geological Society of London, from which may be dated the commencement of the geological survey of Great Britain, was organized in 1807. William Smith, who has been called the father of English Geology, had previously (in 1793) published a geological map of part of England, which was probably the first geological map ever made. The geological survey of France was ordered by the French Government in 1822. These surveys are not yet finished. What, then, can be expected from California, a new country, possessing sixty-eight thousand square miles more of area than Great Britain? The geological survey of California should be continued; the State can well afford it, but cannot afford to neglect it.

The publications of J. D. Whitney's survey are Geology, Volume 1, from 1860 to 1864, printed in Philadelphia in 1865, 498 pages, many wood engravings and plates.

Palæontology, Volume 1. Carboniferous and Jurassic Fossils, by F. B. Meek; Triassic and Cretaceous Fossils, by W. M. Gabb; Philadelphia, 1864; 243 pages, 32 lithographic plates of fossils.

Palæontology, Volume 2. Cretaceous and Tertiary Fossils; W. M. Gabb, Philadelphia, 1869; 299 pages, 36 lithographic plates of fossils.

Ornithology, Volume 1. Land Birds. Edited by S. F. Baird, from notes by J. G. Cooper, M.D; 592 pages, with many wood engravings; University Press, Cambridge, 1870.

Botany, Volume 1. Polypetalæ, by W. H. Brewer and Sereno Watson; Gamopetalæ, by Asa Gray; University Press, Cambridge, 1880; 628 pages, no engravings. Published by the liberality of the following California gentlemen: Leland Stanford, D. O. Mills, Lloyd Tevis, J. C. Flood, Charles McLaughlin, S. C. Hastings, R. B. Woodward, William Norris, John O. Earle, Henry Pierce, Oliver Eldridge.

Botany, Vol. 2, by Sereno Watson; University Press, Cambridge, 1880; 559 pages, no engravings. Published by contributions from S. C. Hastings, D. O. Mills, Henry Pierce, Leland Stanford, J. C. Flood, and Charles Crocker.

Contributions to American Geology, Volume 1. The Auriferous

Gravels of the Sierra Nevada of California, by J. D. Whitney; University Press, Cambridge, 1880. The Museum of Comparative Zoölogy at Cambridge assumed a portion of the expense of publication. From Notes made during the Continuance of the Geological Survey and Re-examination, by Professor Pettee, in 1879; University Press, Cambridge, 1880; 569 pages, with numerous maps and plates.

The Yosemite Guide Book; J. D. Whitney, State Geologist; Cambridge, 1870; 155 pages; with numerous wood engravings and map.

Several other publications of minor importance were issued by the Survey, such as bulletins, catalogues of shells and fossils, etc.

The State Mining Bureau and office of State Mineralogist were created by an Act of the Twenty-third Legislature of California, entitled an Act to provide for the establishment and maintenance of a Mining Bureau, approved April 16, 1880, George C. Perkins, Governor.

The bill was introduced by Hon. Joseph Wasson, representing the Counties of Mono and Inyo.

The Act is published in full in the first report of the State Mineralogist, December 1, 1880.

Henry G. Hanks was appointed State Mineralogist May 15, 1880, his term of office to continue for four years. The history of the Mining Bureau, and the State Museum, will be found in the reports as follows:

First report, from June 1 to December 1, 1880, 43 pages.

Second report, December 1, 1880, to October 1, 1882, 514 pages, with map.

First Catalogue of the Museum, for the year ending April 16, 1880, 350 pages.

Third annual report for the year ending June 1, 1883, 137 pages, with map.

The present is the fourth and last report of the State Mineralogist. This sketch is intended to be a brief history of the most important facts relating to the development of a geological knowledge of the State.

In the following Government publications the geology and mineral productions of California have been duly considered, and much valuable information given:

By J. Ross Browne: Report on the Mineral Resources of the States west of the Rocky Mountains; House of Representatives, Thirty-ninth Congress, Washington, 1867, Ex. Doc. No. 29.

Report on the Mineral Resources of the States and Territories west of the Rocky Mountains; Washington, 1868.

By Rossiter W. Raymond: Mineral Resources of the States and Territories west of the Rocky Mountains; House of Representatives, Fortieth Congress, Ex. Doc. No. 54; Washington, 1859.

Statistics of Mines and Mining in the States and Territories west of the Rocky Mountains; House of Representatives, Forty-first Congress, Ex. Doc. No. 207; Washington, 1870.

Statistics of Mines and Mining in the States and Territories west of the Rocky Mountains for the year 1870; House of Representatives, Forty-second Congress, Ex. Doc. No. 10; Washington, 1872.

Statistics of Mines and Mining in the States and Territories west of the Rocky Mountains, being the fourth annual report; Washington, 1873.

Statistics of Mines and Mining in the States and Territories west of the Rocky Mountains, being the fifth annual report; House of Representatives, Ex. Doc. No. 210, Forty-second Congress; Washington, 1873.

Statistics of Mines and Mining in the States and Territories west of the Rocky Mountains, being the sixth annual report; Washington, 1874.

Statistics of Mines and Mining in the States and Territories west of the Rocky Mountains, being the seventh annual report; House of Representatives, Forty-third Congress, Ex. Doc. No. 177; Washington, 1875.

Statistics of Mines and Mining in the States and Territories west of the Rocky Mountains, being the eighth annual report; Washington, 1877.

By Horatio C. Burchard: Report of the Director of the Mint upon the Statistics of the Production of the Precious Metals in the United States; Washington, 1881.

Report of the Director of the Mint upon the Production of the Precious Metals in the United States; Washington, 1882.

Report of the Director of the Mint upon the Production of the Precious Metals in the United States; Washington, 1883.

By Albert Williams: Mineral Resources of the United States: Washington, 1883; Department of the Interior; United States Geological Survey, J. W. Powell, Director; Washington, 1883.

By Titus Fey Cronise: The Natural Wealth of California. The history, geography, climate, agriculture, geology, zoölogy, botany, mineralogy, mines, manufactures, etc., of the State; San Francisco, 1868.

By John S. Hittell: The Resources of California, comprising the society, climate, scenery, commerce, and industry of the State; San Francisco, 1879, with appendix and map.

CALIFORNIA.

INFORMATION, GENERAL AND STATISTICAL,

IN RELATION TO THE

AGRICULTURAL, COMMERCIAL, MANUFACTURING,

AND OTHER

RESOURCES, INTERESTS, AND INDUSTRIES OF THE STATE.

The Statistical Matter in this Part of the Report has been Gathered and Compiled by
HENRY DEGROOT.

RESOURCES OF CALIFORNIA, ETC.

GEOGRAPHICAL POSITION, AREA, AND NATURAL SUBDIVISIONS OF LAND.

California is situated between latitude 32° 45′ and latitude 42° north, and between the 38th and the 47th meridians west from Washington, being bounded on the north by Oregon, on the east by Nevada and Arizona, on the south by the Mexican Department of Lower California, and on the west by the Pacific Ocean, on which it has a coast line 1,097 miles in length. Measured along its greatest longitudinal axis, which bears nearly northwest and southeast, the State is a little over 700 miles long, and, having an average width of nearly 200 miles, its area approximates 156,000 square miles—in round numbers, 100,000,000 acres of land. Of this land, about 36,000,000 acres may be said to be, in its natural state, well adapted to agricultural pursuits of almost every kind, nearly all of it being equally well suited for stock raising; 30,000,000 acres, producing a variety of nutritious native grasses, constitute good grazing, and for the most part, also, good fruit-growing lands, though little fitted for farming purposes; 20,000,000 acres are mountainous and of not much value for farming or grazing, though nearly the whole of it is heavily timbered; 5,000,000 acres are composed of tule fens and overflowed lands, capable of easy reclamation, and which, possessing a deep, rich soil, must ultimately become exceedingly productive; the balance—5,000,000 acres—consists of alkali flats, lava beds, and sage plains, too saline, arid, and barren to ever be worth much for agriculture, though some portions of them may answer for sheep and cattle ranges.

TOPOGRAPHY—SYSTEM OF MOUNTAINS.

The principal mountains of California consist of the Sierra Nevada, the Inyo, and the Coast Range; the latter, which is made up of a series of parallel ridges and outlying spurs, extending along the western border of the State throughout nearly its entire length. The Sierra Nevada, on the other hand, stretches along the eastern border of the State for at least two thirds of its length, the Inyo Mountains lying beyond and running parallel with a part of the Sierra. In both the northern and southern portions of California occur various cross ranges and groups of mountains, together with numerous isolated peaks, buttes, and clusters of rugged hills; some of which are connected with, while others are wholly separated from, the dominating mountain chains. To the most of these lateral spurs, ridges, and outstanding groups distinct names have been given. Some portions of the Sierra Nevada are very lofty, Mount Whitney, the most elevated peak in the chain, being over 15,000 feet high, and, with two or three exceptions, the highest land in North America. There are several other peaks here that reach an altitude of 14,000 feet, there being many in the Sierra with some also in the Inyo range that vary from 10,000 to 12,000 feet in height. A number of peaks and ridges in the Coast Range approximate a height of 8,000 feet. The lower slopes of the main mountain ranges having been eroded by the swift descending streams into long ridges, undulating prairies, and lawn-like dells, are known as the foothill regions of the State.

THE VALLEYS OF CALIFORNIA

Are numerous and occur under widely varied conditions. Some are small and cradled far up in the mountains; some are larger and inclosed by hills of gentle acclivity, while others are of great extent, expanding into vast plains, little elevated above tide water, the immense depression lying between the Coast Range and the Sierra Nevada, four hundred miles long and fifty miles wide, the southern half known as the San Joaquin and the northern as the Sacramento Valley, furnishing the best example of these valley-like plains to be found in the State. The valleys of California are all fertile, and, while the smaller ones are for the most part tolerably well watered and timbered, the larger are apt to be deficient in this respect. But as tree culture is beginning to be practiced everywhere and water can be supplied to the most of these valleys by artesian boring or be brought in from the neighboring mountains, the above defects will in course of time be measurably remedied.

HYDROGRAPHY.

About one and a half million acres of California territory are covered with lakes, bays, and navigable rivers, the Bay of San Francisco constituting the largest body of water in the State. Besides this California contains only two other wholly land-locked bays—Humboldt and San Diego. Tahoe, one third of which lies in Nevada, is the largest and deepest lake in California, being 21 miles long, 12 wide, and 1,600 feet deep. It lies at an altitude of 6,000 feet, is fed by numerous streams from the adjacent mountains, and through the Truckee River discharges an immense quantity of water. The other considerable lakes in the State are Tulare, Mono, Clear, Klamath, Goose, Wright, Modoc, and Owens. Besides these there are many small deep lakes in the Sierra Nevada, and to the east of that range others so extremely shallow that some of them dry up in the Summer, for which reason they are usually called "mud lakes." Mono, Owens, and some other of these California lakes are so saturated with the carbonate and sulphate of soda, the chloride of sodium, borax, etc., that bathers float readily on the surface of their waters. Some, like Tulare and Honey Lake, cover a large area in the Spring and early Summer, when the snow melts on the mountains, but shrink to comparatively small dimensions later in the season.

The principal rivers of California are the Klamath and Trinity in the northern part of the State, and the Sacramento and the San Joaquin, formed by a great number of tributaries having their sources in the Sierra Nevada, and some of which are themselves streams of large size. These two rivers, flowing the one south and the other north, meet in the middle of the great basin to which they give drainage, and making a deflection to the west, debouch through the Golden Gate into the Pacific Ocean. The southern third of California contains no lakes or large rivers or even streams that in most countries would be called rivers at all, none of them being navigable, while many nearly or wholly dry up during the Summer season.

THE FORESTS AND PARTIALLY WOODED LANDS.

While some parts of California are well timbered others are but sparsely wooded or entirely treeless. The Sierra Nevada to a height of eight thousand feet, as also its higher foothills and some portions of the Coast Range are clothed with magnificent forests of pine, fir, spruce, and cedar; much oak up to four or five thousand feet growing in these forests. The higher foothills of the Sierra Nevada constitute the habitat of the so called "Big Trees," *Sequoia gigantea*, some of which measure at the base over one hundred feet in circumference, and three hundred and fifty feet in height. Being a species of cedar, these trees make a superior article of lumber.

Along the northern coast occurs a belt one hundred miles long, and from ten to fifteen wide, covered with a heavy growth of redwood. These trees, also a species of cedar, reach gigantic dimensions, some of them yielding from 30,000 to 40,000 feet of lumber. The foothills, up to a height of about two thousand feet, are covered with a scattered growth of oak and scrubby pine that burn well when dry, but are worth little for lumber. These oaks generally extend in the form of scattered groves down into the valleys, being about the only trees found there. The most of the larger valleys are in fact but sparsely wooded, what few trees they contain growing along the margins of the watercourses. These valley oaks often attain large proportions, single trees when cut up making as much as thirty or forty cords of firewood. They do not, however, grow to a great height, but have a short thick trunk which throws out many large branches, one of these trees sometimes shading nearly an acre of land. On the sage plains and deserts in the southeastern part of the State grow a few yuca palms and some mesquit trees, the latter a solid heavy wood, and excellent fuel, but the former useless alike for fuel or lumber. The alkali flats, lava beds, and tule lands are without timber. Taken as a whole, California may be considered a well wooded country, her coniferous forests covering some twenty millions acres, constituting, beyond any question, the most valuable timber lands in the world. With these mighty preserves, which when cut away rapidly reproduce themselves, and the much tree culture now going on, nothing but the most criminal waste can ever produce anything like a timber dearth in this State.

SCENERY.

What with her long and lofty ranges of mountains, majestic forests, and park-like hills; her picturesque valleys, deep gorges, and wide, extended plains, the scenery of California may be pronounced unique, grand, and beautiful in the extreme. The towering peaks of the Sierra and the softly rounded domes of the Coast Range arrest the attention, conspicuous from afar, while from many an eminence the great trunk rivers can be seen meandering for hundreds of miles through wheat fields and tule savannas, fed by innumerable streams that tumble in cataracts down the woody slopes of the mountains. Everything here has been projected on a scale well befitting this "Garden of the Gods." The waters of the Pacific lave the State on one side, while the snow-clad heights of the Eastern Cordillera look down upon it from the other. The gates of the Yosemite open into chasms as deep and precipitous as any found elsewhere in the world. Up from the champaign spring pinnacled buttes and crested ranges with chimney-formed rocks, tall and impending, while here and there a volcanic cone stands dark and lonely like a sphinx on the desert, for even these fields of desolation, over which "the mirage dances and the sand-storm sweeps," possess something to charm the lover of solitude as well as to interest the student of nature. How hardly can we find in other countries anything more satisfying to the artist, the tourist, or the scientist, than is to be seen here within the limits of California. The Alps and the Andes enjoy a well deserved fame for the grandeur of their scenery, while the views along the Rhine and the Hudson amount to an enchantment. But California, if she fails to combine all that is best in these, possesses in her scenery so much that is diversified, original, and vast, that it cannot fail to fill the appreciative mind with both admiration and wonder.

CLIMATE.

The most notable thing about the climate of California is its division into a wet season and a dry, the former extending from about the middle of November till the end of April, though it often begins a little earlier and continues for several weeks later. During this season there are generally from twenty-five to forty entirely rainy days, which occur at intervals of two or three, hardly ever of more than four or five, in succession. December and January are apt to be the wettest months, the rain for the rest of the time falling in showers with occasionally an entirely wet day. Very little rain falls during the dry season, sometimes not even a shower from one end of it to the other. The injury caused by such protracted drought is not so great as would at first be supposed, for, while the grass withers and the streams dry up, and the dust accumulates to a fearful extent, these evils are offset by many advantages. The roads though dusty are free from mud; outdoor work goes on without interruption; the farmer may cut his grain at his leisure, as it takes little harm from standing for a week or two after being ripe. Neither the hay nor the grain after being cut is apt to be injured by rain. Having been stacked, or gathered into heaps, the grain can be left to be thrashed, and the hay to be pressed and housed at any time before the wet weather comes on. So, also, the viticulturist may leave his grapes on the vines, and the orchardist his fruits on the trees, long after they are ripe, gathering them when it best suits their convenience. While the grass so dries up and fails to renew itself before the next rainy season, it does not lose its nutritious properties, cattle thriving upon it almost as well as when it is green. Rain occurring during the dry season causes only harm, as it bleaches the substance from the grass after it has been converted into hay, and no one being prepared for it, works much injury besides.

Except on the mountains and higher foothills but little snow falls, nor does much ice ever form in any part of California. The climate along the coast, and for 20 or 30 miles inland, is mild and equable, no extremes of heat or cold being ever felt here. Further inland the Summers are hot and the Winters somewhat colder than along this coast belt. Yet, in all the valleys of California, except the more elevated, apples remain on the trees and vegetables in the ground without freezing, while flowers bloom the whole Winter long. Stock, with the exception of milch cows and work cattle, receive little or no fodder, nor are any but work horses housed during the Winter. There are many localities in the southern part of the State that have over three hundred entirely clear days in the course of the year.

As the climate of California is so genial and temperate, so is it little liable to destructive tempests, violent electrical disturbances, or dangerous meteorological phenomena of any kind. From the cyclones and blizzards that have of late proved so disastrous to life and property in the Eastern States, California is wholly exempt, while the number of deaths from sunstroke and lightning does not exceed a dozen, all told. By the earthquakes, concerning which so much has been said to her disparagement, not over a score of lives have been lost since the American occupation of the country—scarcely more than one on an average every two years. The people of this State know nothing of famines, and little of floods, destructive inundations and damaging droughts being of rare occurrence here. Another good point about the climate of California is its extreme healthfulness. In few other countries is the death rate so small. Endemic diseases can hardly be said to exist here, while those of an epidemic kind generally prove to be of a mild type, being not often attended with fatal results.

POPULATION, WAGES, COST OF LIVING, ETC.

California contains now about one million inhabitants, of whom nearly one hundred thousand are Chinamen. Of these people about thirty thousand reside in San Francisco, where the most of them are employed as domestics, or engaged in washing and manufacturing cigars, clothing, boots, shoes, slippers, etc. Half as many, perhaps, live in the interior cities and towns of the State, where they are in like manner employed. Fifteen thousand work in the placer mines, chiefly on their own account. Several thousand carry on gardening, mostly in the vicinity of the larger towns. A few are fishermen, while a great many are employed in the canneries, at railroad building, in the reclamation of the tule lands, and in picking fruit, grapes, berries, etc., there being but few industries in the State but what employ some of these people.

While the prices of labor in California have been steadily declining ever since the memorable year of '49, the presence of the Chinese in the State has tended to precipitate the wages of the working classes in advance of all other prices, the rates paid for most kinds of labor being now not much higher in this than in the Eastern States. The difference in favor of California, except in the case of some skilled branches, will not average more than twenty per cent. Ordinary farm hands, for example, receive not over $20 per month and found, the year through. Wages during the harvest season range from $35 to $40 per month, or $2 per day and found. In the cities common laborers receive from $1 75 to $2 per day, finding themselves. In the machine shops, foundries, and similar works, daily wages vary from $2 25 to $3, these being about the rates paid in all manufacturing establishments, and about what mechanics, miners, engineers, teamsters, etc., are able to earn in California. Good axmen and sawyers are in demand in the lumber regions at extra high wages. In the canneries, cigar factories, and other establishments where women, girls, and boys can be employed to advantage, the average earnings are not over $1 per day, the usual length of a day's work in California being ten hours.

Although industrially so young, California has made good progress in many lines of production, outranking all the other States in the matter of gold, wine, wool, quicksilver, and barley; while in her wealth of neat cattle and her product of wheat, silver, and silk, she occupies the fifth place. She has also a greater length of telegraph lines and railroads, in proportion to population, than any of the older settled States of the Union, the railroads completed within her borders measuring over 2,300 miles, besides several short lines in course of construction.

The total value of the annual products of California amounts now to $170,000,000. The people of the State have on deposit, in the savings and other banks, $60,000,000. The assessed value of the real estate in California exceeds $500,000,000; the value of personal property approximating $200,000,000.

Taken as a whole, the staple articles of subsistence are not much dearer here than in the Atlantic States. Rents, fuel, water and lights, milk, eggs, butter and cheese, with some other items of prime necessity, are from twenty to fifty per cent higher here than there; flour, fish, fresh meat, fruits and vegetables, furniture, common clothing, boots and shoes, about the same. Considering how little fuel and extra warm clothing are required in California, and how comparatively few days need be lost by reason of sickness or bad weather, the laboring man can afford to live better here, and be able at the same time to lay up more money in the course of the year, than he could do in any other country.

COMMERCIAL PROGRESS.

As the domestic industries and the other material interests of California have prospered and expanded, so also has the commerce of the country grown into large proportions. With an import trade second only to that of New York, San Francisco has such virgin fields to occupy as open not to her great eastern rival. To her the trade of Australia and the Orient, including Eastern Siberia and the islands of the Pacific, geographically as well as commercially belongs, time, freights, interest, and insurance all being in her favor as against every other port in the world.

Although the trade of San Francisco, which may be said to represent largely that of the State, has suffered in some of its departments through the construction of two additional transcontinental railroads, the one to the north and the other to the south of the more central route, it still continues large, and has even increased in the aggregate since the completion of these lateral lines, indicating that this trade is not likely to be seriously crippled by these or other interfering causes. The value of the merchandise and treasure shipped from San Francisco in 1883 amounted to $105,000,000, of which $16,000,000 were consigned to foreign countries. Of these exports $60,000,000 went by sea and $45,000,000 by rail. The imports from foreign countries amounted meantime to $40,000,000, the following staples among other leading articles having been imported in the amounts here mentioned: sugar, 133,914,154 pounds; rice, 58,315,750 pounds;

tea, 20,960,248 pounds, and coffee, 17,444,777 pounds. The receipts of lumber at this port amounted for the year to 276,772,469 feet, valued at $5,000,000; receipts of Federal revenue, $12,558,305.

AGRICULTURE.

It is only about thirty years since the inhabitants of this State began to turn their attention to agricultural pursuits, the most of the manufacturing and mechanical industries that have thus far obtained foothold here not dating back so far, many of them in fact being of recent origin. For the first twenty years after the settlement of the country the principal occupation of our people was gold mining, and not until the surface placers became measurably exhausted did they begin largely to engage in other employments.

THE CEREAL CROPS.

All the grains cultivated elsewhere in the United States are successfully grown in California, and in quantities in the order here mentioned: wheat, barley, oats, corn, rye, buckwheat. There are millions of acres in the State well suited for the cultivation of rice, but none of this grain has been produced, as it can be imported much more cheaply than it could be raised here. The following figures represent about the average annual crop of the above cereals produced in the State during the past five years, the quantities being expressed in bushels, with market value of each attached: Wheat, 45,000,000, value, $50,000,000; barley, 10,000,000, value, $7,000,000; oats, 3,000,000, value, $2,000,000; corn, 3,000,000, value, $2,000,000; rye, 300,000, value, $200,000; buckwheat, 5,000, value, $5,000. These grains commanding in San Francisco within ten per cent the prices current in Atlantic seaports. No grain except wheat, with occasionally a little barley, is exported from the State. The annual shipments of wheat and flour from San Francisco amount to about 1,250,000 tons, of the aggregate value of nearly $40,000,000. A million and a quarter barrels of flour are made from the wheat crop every year, by the 200 flouring mills in the State—120 driven by steam and 80 by water-power. The yield of the cereal crops is from twenty to thirty per cent higher in California than in countries east of the Mississippi River; such a thing as a general failure of these crops having never occurred in the State. Wheat occasionally suffers from rust in the coast counties; it is, also, in districts further inland, sometimes blighted by a hot north wind that blows while the berry is in the milk. The crop is, moreover, frequently shortened by drought, this occurring most often in the great interior valleys.

Unimproved agricultural land in California is cheap, there being much of tolerable good quality still open to preëmption and homestead location. It can also frequently be bought with some improvements on at moderate rates. The Central Pacific and the Southern Pacific Railroad Companies have much good land which they offer for sale at prices ranging from $2 50 to $5 per acre, selling on time if purchasers desire it. While the above class of lands can be obtained at such reasonable figures, highly improved lands, eligibly situated as regards markets, are rather dear—very large prices being asked for properties of this kind when planted with choice fruit trees and vines.

WHEAT.

The crop of this cereal reached in 1883, 43,000,000 bushels, valued at $42,500,000. This is somewhat below the usual product of the State, the crop of 1880 having exceeded 50,000,000 bushels. The State Agricultural Society, in their report issued about the middle of April, while admitting that it was then too soon to figure with much certainty, estimated the wheat crop for 1884 at 48,000,000 bushels. It has since turned out to be over 50,000,000. The wheat fields of California yielded at first an average of twenty-five bushels per acre; but as planting has been extended to lighter soils, and the soil everywhere, through continuous cropping, has tended to deterioration, the yield does not now average over fifteen bushels to the acre—much above the yield in the older States of the Union. Our wheat is apt to be heavy, the most of it weighing sixty and some of it as much as sixty-four pounds to the bushel. Occasionally, however, the berry in some of the large interior valleys is light, being shriveled by a hot north wind that blows while it is in the milk. The flour exports of 1883 were 1,254,519 barrels, valued at $6,158,416. Of late years we have been making more of our wheat into flour than formerly, as by this plan there is effected some saving in freights, California flour being noted for its keeping properties on long sea voyages. China was at one time our best flour customer, but for the past year or two our millers have been shipping more of this article to Great Britain, which becomes now our largest consumer of both flour and wheat. The purchasers of our flour rank in the order here mentioned: the United Kingdom, China, Central America, Australia, Hawaiian Islands, and Panama.

BARLEY.

About 19,000,000 bushels of barley were raised here in 1883, valued at $10,000,000, this being the largest crop ever grown in the State. Much of our barley is ground for horse feed, more, however, goes to the brewers. Our exports last year were 229,168 centals, nearly all to England and the Eastern States; a little also to British Columbia. Barley is a tolerably sure crop in California, the plant not being liable to suffer from rust, insect pests, or the blighting north winds, which sometimes prove so injurious to the wheat while the berry is filling. When this grain is stinted by drought, or grows so rank that it is not likely to fill, it is frequently cut for hay before being quite ripe.

OATS.

Our average crop of oats approximates 3,000,000 bushels, nearly all of which is used for horse feed, a little being ground into meal. Our exports of this grain are small, though we receive a good deal every year from Oregon—price in San Francisco about one and a half cents per pound. The crop with us is a tolerably sure one and the yield about twenty-five bushels per acre.

INDIAN CORN.

Raised in 1883—3,250,000 bushels, the leading corn counties being Los Angeles, with 1,300,000 bushels, and Sonoma, with 1,145,000 bushels. The climate of California, by reason of the cool nights that prevail in the Summer, is unfavorable to the growth of this cereal. A good deal of the corn raised here is of the kind suited for table use, or for canning while green. We do not feed much of this grain to swine, as is practiced in the East, most of it being ground into meal, in which shape some of it is made into bread and some fed to neat cattle. Of late, importations have been considerable—a little, as always, coming from Mexico, but more from Nebraska.

RYE.

Average annual product, 300,000 bushels, San Joaquin County, the largest producer, being credited with a third of the whole. The crop is all consumed at home, mostly for making bread.

BUCKWHEAT.

Five thousand bushels are produced annually; 1,500 in Los Angeles County. As with rye, it is all ground into flour and required for domestic consumption.

HAY.

Compared with the number of domestic animals kept in the State, but little hay is made in California. Receipts last year at San Francisco, 81,472 tons, which represent, perhaps, one fifth of the quantity cured in the State. Price in the city, $12 to $18 per ton, as per quality; delivered on or near the field, about half these rates. Formerly nearly all our hay was made from the wild oats and indigenous grasses; now a good deal is the product of the cultivated grasses, alfalfa chiefly, or of wheat, barley, and oats, cut while green. Millet is being grown to some extent, with a good prospect that it will be found a valuable grass both for dry forage and pasturage. With improved breeds of cattle, we feed more hay now than when the country was overrun with wild Spanish herds, which never received housing or fodder of any kind.

VEGETABLES.

Almost every kind of vegetable can be grown in California, in many localities without, and in nearly all parts of the State with, the aid of irrigation. Under favorable conditions they are apt to grow luxuriantly, some of the vegetables raised here having been noted for their large size. Thus, we have produced squashes of good quality weighing 260 pounds each, a weight of 800 pounds having been grown on a single vine. We have grown cabbages weighing over 50, beets, 118, and watermelons that weighed 65 pounds each, with carrots, turnips, and other vegetables of corresponding size. These dimensions are, of course, exceptional; yet with a good soil and sufficient moisture the vegetables raised here generally exceed those grown in most other countries, both as regards size and weight. Of ordinary vegetables there were raised last year the following quantities: potatoes, common, 350,000 tons; sweet, 3,400 tons, over one half of which were grown in Los Angeles County. While the former kind can be raised almost anywhere in California, San Joaquin, Sonoma, San Mateo, Los Angeles, and Mendocino may be accounted the principal potato-growing counties of the State. Our only foreign customers for this esculent are the Chinese and the Sandwich Islanders, the former taking a good many every year. Our onion crop averages 400,000 bushels, Alameda and Los Angeles being preëminently our onion-producing counties, the former turning out about 60,000 and the latter about 55,000 bushels annually. Beans, 375,000 bushels—forty per cent of the whole raised in Santa Barbara County. Castor beans, 1,200,000 pounds, all the product of 900 acres in Los Angeles County. Peas, 65,000 bushels; Humboldt, the banner county, 43,000 bushels. This estimate does not include green peas, of which many are consumed in the State. Of pumpkins, squashes, melons, and vegetables of nearly every other kind, we raise such quantities that they are in their season supplied to the markets at very low prices. There are few articles in this line but what can be found fresh in the San Francisco market the year round.

FRUIT RAISING, CURING, AND CANNING.

The number of fruit trees in California of the kinds mentioned below is estimated at 8,000,000, subdivided as follows: apple trees, 2,700,000; peach, 1,200,000; pear, 500,000; plum and prune, 600,000; cherry, 400,000; apricot, 500,000; orange, 1,600,000; limes and lemons, 500,000; besides which there are several hundred thousand fig, olive, quince, and various other fruit-bearing trees, not to mention a vast number of currant and berry bushes of every description. As this class of trees are apt to be prolific bearers, the fruit crop of California is always large, so large that much of it in remote localities is left every year to perish ungathered. Vast quantities of it are, however, preserved by drying or by bottling and canning, this business having reached large dimensions and proved both safe and profitable.

Fruits of almost every description can be grown all over California up to an altitude of 2,500 or 3,000 feet, apples, pears, plums, etc., maturing in the mountain valleys at elevations of 5,000 feet.

DRIED AND CANNED FRUITS.

Curing fruits by the process of desiccation is done either by sun or artificial drying, the later being effected by machines or ovens heated for the purpose, and many of which are coming into use in California. Our dried fruit amounts to about 3,000,000 pounds annually, the most of it consisting of apples, peaches, pears, prunes, figs, and plums, nearly one third of the whole being cured by machine drying. These fruits are in request in the eastern markets, to which a good deal is sent every year. Some is also sent to different parts of the Pacific Coast, and a little to other countries.

At the fruit and vegetable canneries, twenty-five in number, scattered over nearly all parts of the State, there were put up last year a total of 1,025,000 cases. Of these 750,000 cases consisted of fruits and berries, and 275,000 of vegetables, the whole having a market value of $4,500,000. These establishments have capacity to put up from 2,500 to 200,000 cases every year, the number of persons employed in them varying from twenty-five or thirty to fifteen hundred. Of the products of these canneries we export seventy-five per cent, the balance being consumed at home. These goods, like our dried fruits and canned salmon, are sent to many different countries, England, the Eastern States, and the Territories west of the Rocky Mountains taking the major portion of them. Some are sent, also, to British Columbia, Mexico, Central and South America, the Sandwich Islands, Australia, China, Japan, etc. Of our early fruits large quantities, also grapes, are shipped in their green state to Chicago and other eastern cities. The cost of putting up fruits in this manner amounts to $1 75 per case of twelve cans. Our importations in the line of canned goods consist mainly of oysters, condensed milk, chicken, turkey, pineapples, meats, and some few fruits and vegetables that we do not produce in full supply, or which may be required to replenish exhausted stocks. Imports of these latter are diminishing every year.

Although a great deal of the fruit grown in this State is disposed of while green, the most of it is preserved either in hermetically sealed vessels or by the process of drying. Of the earlier varieties much is shipped east by rail, also large quantities of grapes, berries, etc., the total amount so disposed of averaging about 15,000,000 pounds annually. We also supply our more immediate neighbors largely with these articles. Some green apples are sent as far off as the Hawaiian Islands and Australia.

DOMESTIC ANIMALS.

Of horned cattle, California contains now about 800,000 head, not a third of the number in the State thirty years ago. But the cattle now on hand are largely of improved breeds; a considerable proportion being kept for dairying purposes; whereas formerly the entire number consisted of Spanish cattle, raw-boned and half wild, raised only for their hides and tallow. While they are pretty well distributed over the State, the central and southern counties have a preponderance of the neat cattle.

Of horses and mules, California numbers about 300,000 of the former and 28,000 of the latter. The horses consist of pure-blood animals, wild Spanish stock, and a cross between the two. Many of the mules are also of improved breeds.

We have at present something over 5,000,000 sheep in this State, from which there were clipped last year 40,848,690 pounds of wool, valued at $8,000,000. With us these animals commence to breed early and multiply rapidly, the annual increase averaging about fifty per cent. With nearly all who have engaged in it, sheep raising has proved a profitable business. Of our wool clip, 7,000,000 pounds are manufactured into goods of various kinds, mostly cloths and blankets of the finer varieties, the rest being shipped to eastern markets.

We have probably 20,000 Angora or Cashmere goats in the State, the present stock being largely crossed with the common varieties. Being unacquainted with the business, our first trials with these animals have been disappointing. As we have much land well adapted to the wants and habits of these goats, and as their fleeces are in demand, there is little doubt but there will yet be large numbers of them raised in California. Some of the flocks have already proved profitable.

SWINE.

We have about 400,000 of these animals in the State, less by one half than we had twenty-five years ago, when, breeding without much care, thousands of them ran wild in the tule lands, and their range was generally less restricted than at present. Our annual slaughter of hogs averages about 250,000, their product last year being: ham, 4,850,000 pounds; bacon, 5,325,000; lard, 2,880,000, of the estimated value of $2,000,000. Of these articles, we import from States east of the Rocky Mountains largely every year. As with increased irrigation there will be grown more of the succulent grasses and roots necessary for the sustenance of swine, it may be expected that a larger number of these animals will be raised in California hereafter, enabling us to become more nearly self-sustaining in this line of products. The hog does not thrive in the agricultural districts of the State, as these afford but little mast and not enough Summer moisture for his comfort.

POULTRY.

Domestic fowls, as a general thing, do well in California. where a great many of one kind and another are kept. In some of the coast counties chickens are subject to diseases which in many cases prove fatal. The increased value of the poultry last year is estimated at $100,000. Eggs being largely consumed here, many are imported from the Western States, also some from Utah. Both eggs and poultry are considerably dearer here than in the Eastern States.

DAIRIES AND THEIR PRODUCTS.

The business of dairying is carried on extensively in California, the annual product of butter having for a number of years past averaged about 11,000,000 pounds; cheese, 4,000,000; about four tenths of the butter having been made in Marin, and one eighth in San Luis Obispo County. At certain seasons of the year we ship butter to the East, receiving at others a little butter with some cheese from choice dairies in return. Our imports of cheese come, however, mostly from Switzerland. We supply butter to British Columbia, the Sandwich Islands, and other of our neighbors. Many California dairymen keep large numbers of cows. Messrs. Howard & Shafter had at one time on their ranch in Marin County as many as 3,500 head, divided up into seventeen dairies. The Steele Brothers of San Luis Obispo County, keep from 600 to 800 head, and there are probably a hundred dairies in the State that have from 50 to 100 head each. Our milch cows are either of the pure English breeds, American animals, or a cross of these, mixed sometimes slightly with the lank, long horned Spanish stock, which are poor milkers.

VITICULTURE.

GRAPES, WINES, AND RAISINS.

If there is one thing in the vegetable domain for which the soil and climate of California are better adapted than any other, it is their fitness for growing the grape. Nearly the whole State below an altitude of three or four thousand feet, may be said to consist of tolerably good, the most of it first class, vine lands. We have probably more land of this kind within our borders than France and Italy combined. While so nearly the whole of California may be considered the habitat of the vine, the territory best suited for its culture is comprised in a belt reaching laterally from the western slopes of the Coast Range to the higher foothills of the Sierra Nevada, and extending the entire length of the State, a distance of nearly 700 miles. The cultivated grape has been grown successfully in California for a long time, the first plantings having been done by the Catholic Fathers more than a hundred years ago. The vine set out by them, though hardy and a good bearer, yields rather a common sort of fruit, known here as the Mission or Los Angeles grape. For several years at first our modern plantings were mostly composed of this grape. Of late, however, it is being superseded by better and generally very choice varieties.

Charles A. Wetmore, an authority in all that relates to viticulture in California, estimates that we have now 160,000 acres planted to vines, such estimate including 30,000 acres set out the present year. Calculating 800 vines to the acre—about the average—gives 128,000,000 vines now in the ground, of which a third are in full or partial bearing. Mr. Wetmore is of the opinion that we shall have in another year as large an area as 70,000 acres of vines five years old and upwards, and that such area will in the course of four years more be enlarged to nearly half a million acres, containing over 400,000,000 bearing vines.

Our vintage of late years has been as follows: 1881, 12,000,000 gallons; 1882, 9,000,000; 1883, 9,500,000. Calculated on this basis, the product of our vineyards for the near future may be estimated as follows: 1884, 12,000,000 gallons, with possibilities of 14,000,000; 1885, 15,000,000; 1886, 20,000,000; 1887, 25,000,000; 1888, 33,000,000 gallons. For a number of years past the value of the California wine product has averaged about $6,000,000 per annum, though last year, owing to a short grape crop, it amounted to only $5,000,000. Brandy from the grape, of which several hundred thousand gallons are made every year, is not included in the above estimates.

The more obvious defects of our California wines have been due to lack of skill and care in their manufacture, and to insufficient age. They have not, as a general thing, been wanting in inherent good properties, and the above causes of their defects are being every year diminished. They have this further to recommend them to wine drinkers everywhere: they are absolutely pure, our vintners practicing no adulteration whatever. It is true they have recourse sometimes to the subterfuge of selling their wines under foreign labels, this being a concession to the preferences of a certain class of consumers, who, having been accustomed to the use of foreign brands, the accommodating vintner, more often the retailer, takes this method for gratifying the tastes of his customers. With the considerable experience our people have had in the business of wine making, and the practice of storing for age every year extending, coupled with the fact that the later plantings have largely consisted of the better class of vines, there can be little doubt but the bulk of the wines turned out in this State will, in the course of a few years, be superior to those produced in any other part of the world.

The price of grapes per ton, delivered at the wineries, has, for the past five years, been as follows:

	Mission.	Foreign.
1879	$14@16	$18@26
1880	18@23	30@35
1881	20@22	28@35
1882	17@18	30@36
1883	18@25	25@35

Grapes of the kinds suitable for table use and raisin making command somewhat higher prices than the above. Of the vintage about twenty per cent is consumed for these and like purposes, eighty per cent going to the wine press.

The yield of our vineyards varies with seasons and other conditions, the average being from four to five tons per acre. Cuttings begin to bear here the second year after being set out, the vintage thence on increasing for a number of years. Not only is the vine with us a thrifty grower and early bearer, but it is apt to be long lived as well, there being examples of some set out nearly one hundred years ago still bearing abundantly.

The wine product of California is disposed of as follows: We consume at home about 4,000,000 gallons; export 3,000,000 gallons; retain for aging 3,000,000 gallons; 3,000,000 gallons of brandies and sweet wines being distilled from wines, sediments, and pressings. Our exportations of wine during the past ten years have been as follows:

	Gallons.
1874	1,000,000
1875	1,031,507
1876	1,115,045
1877	1,462,792
1878	1,812,159
1879	2,155,944
1880	2,487,353
1881	2,845,365
1882	2,916,775
1883	3,100,000

Exports of brandy meantime have been:

	Gallons.
1874	40,000
1875	42,318
1876	59,993
1877	138,992
1878	129,199
1879	163,892
1880	189,098
1881	209,677
1882	214,162
1883	220,500

Many of the vineyards of California are very extensive, numbering from 200,000 or 300,000 to 500,000 vines each. It is probable that this State can boast of the largest single grape plantation in the world, that of Governor Stanford, at Vina, in Tehama County, comprising 10,000 acres, 2,800 acres of which has been planted with vines mostly of choice varieties.

California offers all the conditions requisite to the production of a good and a cheap raisin. As with wine, the earlier attempts at raisin making failed to produce a perfect article. But lately such improvements have been made in the business that it may now be considered a complete success, many of the California cured raisins being nearly or quite equal to the best imported. The industry is bound to expand rapidly and reach ultimately large proportions. The curing of last year amounted to 130,000 boxes of 20 pounds each, which sold in the market at the average rate of $1 35 per box. The product last year was much less than may ordinarily be counted upon, the early rains having greatly injured the fruit and interfered with the process of curing.

STATISTICAL SUMMARY.

While we have in California a great variety of pursuits, interests, and improvements, each entitled to extended comment, only a few, even of the more important can, in a cursory review like that here contemplated, be noticed with much fullness. Reserving what relates to the more useful minerals and metals, and the industries and enterprises connected with their development, to be described more in detail further on, we give below an epitomized account of most of the leading industries of the State.

Summarizing, we present first the following

COMPREHENSIVE EXHIBIT,

As tending to illustrate in a general way the progress heretofore made, and the present financial, commercial, and industrial status of California: The State now contains 1,000,000 inhabitants, which number is being increased through births and immigration at the rate of 60,000 per year. With her available lands all occupied, and her natural resources fully developed, California would be capable of sustaining a population of 20,000,000. She has within her limits real estate of the assessed value of $500,000,000; personal property, $200,000,000; 9,000,000 acres of land inclosed; 7,000,000 under cultivation; value of annual products, $180,000,000. As a State she is practically without any debt. Deposits in savings banks, $60,000,000; banking capital of the State, $50,000,000; annual bullion product, $18,000,000; average value of wheat crop, $45,000,000; barley, $10,000,000; dairy products, $8,000,000; fruit crop, $7,500,000; wool, $8,000,000; wine, $5,000,000; value of lumber made in the State, $5,500,000; hay cut, $13,000,000; value of domestic animals of all kinds, $60,000,000; value of animals, poultry, etc., slaughtered every year, $23,000,000; increased value imparted to manufactures, etc., by labor, $40,000,000; number of grapevines set out, 130,000,000; fruit and nut trees, 800,000, with five times as many forest, shade, and ornamental trees. The State contains 3,500 miles of telegraph lines; 3,300 miles of railroad; 5,000 miles of mining, with an equal extent of irrigating, ditches; 400 quartz mills; 300 sawmills, and 185 flouring mills; $250,000,000 have been invested in mining improvements in the State, cost of quartz mills, tunnels, and ditches included.

VARIOUS AGRICULTURAL PRODUCTS AND MINOR PURSUITS.

We have in California a great many industries which, being of secondary importance or but remotely connected with the subject of mining, have here been roughly classified and disposed of in a summary way, since to enlarge upon them as their merits deserve would swell this paper to undue proportions. While our method of treating them amounts to hardly more than making a catalogue of these collateral and minor topics, we have felt that they should not, in a paper of this kind, be wholly overlooked. Proceeding then to deal with this class of subjects in the manner indicated, it may be observed that—

IN THE DOMAIN OF AGRICULTURE, we have experimented widely and successfully; growing, maturing, and generally bringing to the highest perfection, all the products of the temperate, with many belonging to the semi-tropical, zones. We raise every important cereal known to agriculture; wheat and barley in great quantities. The orange, lime, and lemon have become staple fruits in California; and even the banana, heretofore deemed a purely tropical plant, has ripened its fruit in some parts of the State. If some of our trials with vegetable products have proved disappointing, this has, as a general thing, been due to the high prices of labor, lack of skill and care in their cultivation, or to the presence of other unfavorable conditions aside from soil and climate; and that we have met with a few disappointments in this respect must be admitted. Our experiments with coffee, tea, tobacco, sugar cane, sorghum, ramié, and cranberry growing have, for example, turned out but poorly, and in some cases for the reason that our climate is not suitable for the cultivation of these products, frosts having injured the ramie and coffee plants or killed them outright. In the matter of tea and tobacco, while the curing was no doubt faulty, the leaf of both was lacking in flavor. The cranberry failed because the site was injudiciously chosen and the soil badly prepared, there being plenty of land in California well adapted for the cultivation of this berry, and tobacco, as well. As regards ramié, there is a large extent of bottom lands on the Colorado River where it could be successfully grown, if nowhere else in the State. Not having as yet succeeded in supplying ourselves with the commodities here mentioned, we import the most of them; tea, from China and Japan; coffee, from Mexico, Costa Rica, Brazil, and other parts of the world; tobacco, from Cuba and the Eastern States; sugar, mainly from the Sandwich Islands; and cranberries, from certain of the Western States, also a wild fruit, in considerable quantities, from British Columbia.

The broomcorn we raise is made into brooms, wisps, brushes, etc., of which we send annually about 4,000 dozen to interior and coastwise markets, also some to the Sandwich Islands, Australia, and the Orient, retaining, perhaps, twice as many for our own use. Owing to the dryness of the climate, the California broom is hardly as tough as that grown in the East. We make most of our mustard, chiefly from the cultivated, partly from the wild, plant, which latter covered at one time the rich valley lands in many parts of the State with a growth so sturdy that it stubbornly resisted the efforts of the farmers at rooting it out, many plowings having been required to effect that end. The chicory we raise, though scarcely equal to the German, being cheaper, is making headway against the latter. Buhach, the plant from which the so called Persian powder is made for killing fleas and other insects, is grown quite extensively and profitably in Kern County—a little, also, elsewhere in the State. This powder has been found very effective for the destruction of insect pests of various kinds, and so much is it being employed for this purpose that the verb "to buhach" has come into common use among vine-growers and horticulturists in some parts of California. The guava plant is being cultivated in the neighborhood of San Diego with the prospect of its becoming very remunerative. Though highly esteemed for table use, most of this fruit is made into jelly.

IN THE DEPARTMENT OF WOODWORKING

We accomplish a great deal—make furniture in large quantities and of every kind, from the most elegant rosewood parlor set to the rawhide-bottomed chair, and this, notwithstanding few of our native woods are well suited for the purpose. Latterly this business has been a little depressed owing to the completion of the Northern Pacific Railroad, causing the eastern to compete sharply with our local manufacturers for the Oregon trade. The product of our shops is in nowise inferior to the best made elsewhere, suitable woods being largely imported, and the services of artisans trained in eastern and European factories having been secured in all our larger establishments. We dispose of but little home-made furniture except to our immediate neighbors. Our manufacturers are paying increased attention, not only to the selection and seasoning of their woods, but also to fashioning and finishing their wares, insuring to their customers articles of greater excellence than they were able to turn out at first. Besides furniture in such variety, we manufacture pianos, organs, and other musical instruments, picture and mirror frames, billiard tables, etc. The construction of wheeled vehicles is a great business in California, extending to every kind of conveyance, and being carried on throughout all parts of the State, and this despite heavy importations both by land and sea. Owing to the high wages paid workmen, labor-saving implements and machinery of all kinds have ever been in great request in California. Especially with the large grain raisers has this been the case, hence the heavy importation of gang plows, seed sowers, harrows, mowers and rakers, reapers, thrashers, separators, etc., and this notwithstanding we make at home great numbers of these articles, there being at least a dozen establishments in the State devoted to their manufacture. To San Francisco the north coast as far up as British Columbia, also, Mexico, Arizona, and the Sandwich Islands, look for their supplies in this line, either wholly or in part.

As much water requires to be raised during the long dry seasons that prevail in California, windmills in great numbers are availed of for this purpose. These machines, the most of which are made here, are of diverse patterns—some simple and cheap, costing not over $50, others large and complicated, costing as much as a thousand or fifteen hundred dollars—average cost, about $200. The windmill is employed here for raising water, not only for domestic, but also for irrigating and manufacturing purposes. We make now on this coast, mostly in San Francisco, about all the woodenware we require, and of which we consume annually values to the amount of $250,000. Some articles in this line, such as ax and pick handles, whip-stocks, chopping trays, etc., we obtain from the East, because we have not here suitable woods for making them. This deficiency will, however, be in good time supplied, as arboriculturists are taking pains to plant such trees as will furnish this much needed kind of lumber. Of willowware we make yearly about $12,000 worth, our imports amounting to four times as much. The business, which requires but little capital, is carried on by eight or ten different parties, each in a small way—some basket-making and rattan work being generally connected with it. All the raw material is imported, but as we have any amount of waste tule land suitable for growing the osier, economy suggests that we raise enough of it for our own use, which we will probably do before long. In a country so prolific of fruits and wines, boxes and casks must necessarily be in large demand; hence, the incredible number of these articles made up every year in California. Owing however to the cheapness of lumber, this package tax is not very onerous. While most of the cooperage business is done in San Francisco, there is still a good deal carried on throughout the wine growing districts of the State. Among the smaller articles made from wood, we manufacture faucets and bungs, lasts, matches, etc. Our matches are so cheap and so good, that we export every year about 5,000 cases of them, against only a few hundred imported, although the importation was at one time very large.

IN METALS, FROM THE MOST PRECIOUS TO THE MOST COMMON KINDS;

We have from pioneer times been great workers. Inhabiting a region so abounding in gold and silver, we naturally took to the manufacture of plate, jewelry, and other articles of ornamentation at an early day, and have since done much at the business, in which our artists have reached great proficiency. Of our achievements in working up iron something has been said in the articles pertaining to our foundries, machine shops, etc. But in addition to iron we have establishments that manufacture articles and wares from all the other useful metals, the number of hands employed in them amounting to at least 2,000—gross value of products, $5,000,000. With us the wages paid workers in metals rule high, about seventy-five per cent higher than prevailing rates in the Atlantic States. Our brass and bronze foundries use up copper, tin, zinc, lead, and antimony to the amount of 600 tons annually, and produce everything usually made at similar works elsewhere—products valued at $500,000. Our lead works, described more fully elsewhere, employ 150 hands, and turn out products to the value of $800,000 per annum. There are, probably, 150 tinshops in California, Chinese and repair shops counted in—value of products, including such sheet-iron wares as are usually made in connection with this business, $1,200,000; hands employed, 600, one fifth of them Chinese; capital invested, $575,000. Formerly our importations in this line were large; they now scarcely exceed $400,000 per year, consisting mostly of "pressed" wares. Our coppersmitheries, all but two or three located in San Francisco, employ 60 men, at $3 50 per day, and manufacture wares to the value of $250,000 annually. Gasfitting and plumbing, japanning, galvanizing iron, silver plating, gold beating, and gilding are all carried on here to a greater or less extent. We also manufacture some cutlery, firearms, mathematical, telegraphic, and electrical instruments, clocks, watches, etc. Of the tacks, nails, files, and other articles of hardware, made by the Judson Manufacturing Company, mention is made in our article on the works and products of that company. We have two stove factories, although as yet not much hollowware or other domestic utensils have been cast in the State. The value of our home-made stoves amounts to about $300,000 per year—imported, $1,000,000. We shall soon make about all the stoves required in California, and, probably, some for exportation.

While our soap and candle factories turn out large quantities of good articles in their respective lines, we continue making heavy shipments of tallow to the East, where it is made up into soap and candles, brought back and sold to us with cost of freights, manufacture, interest, and insurance added. Of turpentine we produced during war times all we wanted for our own use, but shipments being resumed, on the restoration of peace, prices so declined that the home manufacturer was obliged to abandon the business, being no longer able to compete with the imported article. As we have vast forests of terebinthine trees, there is little doubt but we will yet produce not only enough pitch, tar, and turpentine for our own use, but enough for our commercial neighbors.

Three Italian paste companies, operating in San Francisco, supply not only the wants of the coast, but also the export demand, now considerable, with macaroni and vermicelli, employing, of course, only California flour in their manufacture.

We have several cracker factories in the State, all the larger ones being located in San Francisco. The works of the California Cracker Company are said to have capacity equal to any in the United States. While we make some gutta percha and rubber goods, the bulk of such goods used here continues to be imported. We prepare cocoa for chocolate, of which the several factories in San Francisco turn out a good deal. We make both writing and printers' inks; varnish, to the amount of 60,000 gallons yearly; besides which, we import 20,000 gallons, all consumed at home. We make artificial limbs to the value of $10,000 or $12,000 per year; some smoking pipes, both wooden and meerschaum, but none of clay—about one fourth of the shoe blacking used in the country; 30,000 pairs of lasts, some of which are sold abroad. Two axle grease factories, both located in San Francisco, employing about a dozen hands, make annually 150 tons of this lubricant, valued at $45,000; besides this, we import from the Eastern States 50 tons. Our exports of axle grease, amounting to 25 tons, go mostly to Mexico, British Columbia, the Sandwich Islands, and Australia. A dozen mills, three fourths of them located in San Francisco, grind up spices, mustard, chicory, etc., to the value of $2,000,000 per year. Our imports of pepper, nutmeg, cloves, cassia, and allspice, amounted in 1883 to 1,049,850 pounds, double the quantity imported any previous year. The only safes made on the coast are manufactured in San Francisco, by Jonathan Kittredge, on orders for articles of great size or of patterns not made for the trade. We import all others; also, nearly all the locks, keys, etc., required on the coast. An attempt was made to establish a lock factory here some years ago, but it did not succeed. Chains of extra large size we make; smaller and poorer ones are imported. Mattress springs are manufactured in San Francisco. Seventy-five per cent of our wagon and carriage springs are brought from the Atlantic States at an annual cost of about $260,000. Four foundries, employing 45 hands, make $50,000 worth of type every year; besides which, we expend about an equal amount for imported printers' material of various kinds. We make a few rubber and gutta percha goods, importing of these articles to the extent of $1,000,000 worth annually. We have mills that clean rice, grind salt, plaster, etc. We manufacture trunks, carpet sacks, satchels, etc., to the value of $350,000 per year, this branch of business giving employment to 200 operatives. We make annually 4,700 barrels of glue, of the aggregate value of $85,000. The most of this article we export, three fourths of it to New York. The single surviving starch factory of several that have been started in California, turns out annually 100 tons of this commodity, valued at $16,000. Our imports, mostly from the Eastern States, amount to 1,200 tons; exports, 80 tons, our principal customers being Mexico, British Columbia, the Sandwich Islands, and China. The manufacture of clothing of every description; straw, felt, and silk hats; gloves, slippers, and regalia; parasols and umbrellas; neckties, suspenders, and an infinite variety of similar small articles, is carried on very extensively in San Francisco, though it is greatly to be regretted that so large a proportion of these employments, which ought to be reserved for the women and the youth of both sexes, is here engrossed by the Chinese.

MANUFACTURING, MECHANICAL, AND OTHER LEADING INDUSTRIES OF THE STATE.

GUNPOWDER AND OTHER EXPLOSIVES.

We manufacture in California the various explosives, high and low, to the value of about $2,000,000 annually. We also import from the Eastern States considerable powder, both sporting and blasting, though the quantity is being gradually diminished. Our exports are chiefly to Mexico and British Columbia, with a little to the Hawaiian and other of the Pacific Islands, and amount to about 800,000 pounds per year, valued at $133,000. During the past year the home consumption, owing to some abatement of railroad building and hydraulic mining, has been less than usual. The capital invested in powder making, all the various kinds included, amounts, probably, to $3,000,000; number of hands employed, 300, many of them Chinamen; wages paid vary from $1 25 to $3 50 per day. Of the crude stock, the acids, charcoal, and part of the glycerine, are made in the State. The nitrate of potash is imported from Calcutta, and the nitrate of soda from Peru, the sulphur being obtained mostly from Sicily and Japan, with a little sometimes from the State of Nevada.

The California Powder Works—Located near the town of Santa Cruz—constitute the only establishment in California at which the various kinds of common or black powder are made. These works, which give employment to about 50 hands, all whites, are very extensive, comprising 21 powder mills, 10 shops, 6 magazines and stores, besides 35 other buildings. In their equipments they are very complete, embracing all the machinery and processes pertaining to the manufacture and putting up of gunpowder, from the distillation of wood for charcoal and the refining of niter to the final packing in wooden and iron kegs, all of which are made on the premises. The powder produced at these works includes both the fine and coarse varieties, such as sporting, blasting, etc., some of it being especially adapted for subterranean and submarine blasting. It enjoys an excellent reputation, having been able to nearly monopolize the trade since the company was organized, more than twenty years ago.

The same company have put up works at Pinole Point, on the shore of San Pablo Bay, in Contra Costa County, for the manufacture of Hercules powder, a business prosecuted here on quite an extensive scale. This, like their powder works near Santa Cruz, is a very comprehensive establishment, comprising large factories for making sulphuric and nitric acids. The Hercules powder from Pinole Point has come into general use on this coast, having commended itself to consumers both for its strength and safety.

Besides the foregoing we have several other companies engaged in making the high explosives in California, such as the Giant, Vulcan, Safety-Nitro, Vigorite, etc. Owing to the diminished requirements, these companies, finding they were making such an over production as prevented their realizing any profits, agreed among themselves in May last to so restrict the output of their works that some advance in prices would be possible. Although no higher rates for powder have yet obtained, this may soon be looked for, as a new schedule of prices has been agreed upon.

Fireworks.—We burn on the coast fireworks to the value of $80,000 annually, the consumption of these articles being less now than formerly, by reason of municipal ordinances restricting their use in the larger cities. Three factories in San Francisco, employing 15 hands, make the fixed or larger pieces, the smaller, such as crackers, rockets, etc., being brought from China. The import trade is mostly in the hands of the Chinese, with us the principal consumers of this style of combustible. We supply firecrackers to the surrounding countries and send a few to Mexico and South America.

Blasting Fuse.—We have three factories in California making this material. They employ about 40 hands and make enough fuse to supply the wants of the mining regions as far east as Colorado, including British Columbia and northwestern Mexico.

WOOLEN MILLS AND GOODS.

Of the 40,000,000 pounds of wool annually produced in California, about one sixth is manufactured into various fabrics at home, and the remainder exported to eastern markets. There are eleven woolen mills now operating in the State, located as follows: two at San Francisco, and one each at Napa, Santa Rosa, San José, Marysville, Sacramento, Stockton, Merced, Los Angeles, and San Bernardino. A company with a capital of $100,000 has been formed and taken active measures for building a woolen mill at Gridley, in Butte County. The project of building a like establishment in Fresno County, and at one or two other points in the State, is now being considered, and it may safely be calculated that the present number of our woolen mills will be largely added to in the course of a few years. Those now running employ about 1,800 hands, one fourth of them Chinamen, the most of this race being employed in the two large mills in San Francisco. The capital invested in this branch of industry amounts to about $2,500,000—value of goods annually turned out, $3,200,000—wages paid out, $700,000 per year. The articles manufactured in this line consist mainly of blankets, flannels, cassimeres, cloths, yarns, and knit goods of various kinds. Our importations of woolen goods are heavy, and may be expected to so continue till buyers find out the superiority of our all-wool fabrics over eastern shoddy.

TEXTILE FIBERS AND FABRICS—SILK, COTTON, AND JUTE MILLS—SERICULTURE.

While we can grow in California all the fiber plants except such as are purely tropical, our advantages for the production of silk are notable—unequaled, perhaps, by those of any other country. The mulberry tree can be raised here with little trouble, growing much more rapidly than in France, and yielding more leaves. It has with us such power of recuperation that when trimmed down it throws up shoots from ten to fifteen feet in length in a single year, nor does it suffer under judicious cutting of this kind. Two crops of cocoons can be raised yearly, one in May, and the other in July, no artificial heat being required. Here we have none of that heavy thunder, and the long cold rains, that so injure the eggs and kill the worms in all parts of Europe. Here, instead of having recourse to kilns for stifling the chrysalis, as in other countries, this is effected simply by exposure to the solar rays, which, under the cloudless skies of California, is all sufficient. With a climate so equable and genial the cost of shelter is little. The worms so far have been free from disease, and there being no severe cold to interfere they work continuously. Incited by these favorable conditions, and the premiums offered by the State as an encouragement to sericulture, many of our people began planting the mulberry tree, procuring the eggs and breeding the worms more than twenty years ago. Barring such slight disappointments as arise from the mistakes incident to every new business, these efforts have been attended by the most gratifying results. We have now many millions of these trees growing in the State, and quite a large number, mostly women, girls, and boys, engaged successfully in the business of gathering the leaves, feeding, and otherwise looking after the worms. The calling is admirably suited to these classes, the labor being light, simple, and cleanly, while the methods of feeding, spinning their gossamer filaments, and the other habits of these strange creatures, are exceedingly curious and interesting. At first we procured the most of our eggs from Japan, those produced in France and Italy being at that time much diseased, and for several years these countries drew on us for more healthy eggs. Later we began to displace the Japanese with the Italian egg, which is now greatly preferred to any other. We have now two factories in this State, both located in San Francisco, engaged in making various kinds of silk goods, the one turning out skein, spool, knitting, and embroidery silks, and the other piece goods. The products of both these establishments are in great favor, being preferred by the trade to imported articles. These factories employ about 150 hands, mostly women and girls, and turn out aggregate values to the amount of $350,000 per year. Skilled laborers having been procured from Europe, these employés have been carefully trained, and are now adepts in the art of filature, weaving, and all else that relates to the manufacture of silk goods of the finest quality. The outlook for this industry, both as regards the production and manufacture of the fiber, is most encouraging in California.

Cotton.—Although cotton planting commenced in this State as early as 1870 no great progress has been made in the business, the retarding causes consisting mainly in the cost of labor and the considerable amount of it called for, the plant here requiring irrigation. The work of picking is also somewhat more laborious than in the Atlantic States, by reason of the dry Summers here causing the fiber to adhere more firmly to the stem. With irrigation, however, good crops can be made in the interior of the State, the yield being large and the staple excellent. The annual product of California has for some years past averaged about 250,000 pounds, seven eighths of it being raised in Merced, and the balance in Kern County. It has proved to the cultivators a fairly profitable crop, and more of it will probably be raised hereafter, as two companies have been organized for putting up cotton factories in the State, the one to be located in East and the other in West Oakland. These projects are in a state of forwardness, and being engineered by parties of ample means, will no doubt be pushed to an early completion. The mill at East Oakland will make jute as well as cotton goods, one of the specialties here being the manufacture of seamless flour and grain sacks. The conversion of the cotton factory erected at East Oakland in 1865 into a jute mill had a depressing effect on the cotton-growing interest of California by depriving planters of the limited home market they had before enjoyed. When it is considered that there is imported into the United States cotton fabrics, mostly fine goods, to the value of $40,000,000 annually, it would seem as if we on this coast ought to be able to grow cotton and manufacture it into the coarser kinds of articles to advantage.

Flax and Hemp.—That the cultivated flax would thrive in California might be inferred from the fact that the plant grows wild in many parts of the State. The indigenous stalk produces a good lint, of which the Indians formerly made much use. We have grown the plant here successfully for many years, but for the seed only, very little use having as yet been made of the fiber, though the stalk yields a strong heavy coat. The crop is a profitable one raised for the seed alone, for which the oil mills—two in the State—pay two and a half to three cents per pound, the yield of seed being at the rate of about 950 pounds to the acre. Our yearly product of this seed averages a little over 5,000,000 pounds. Of this quantity San Luis Obispo County turns out over 3,000,000 pounds; San Mateo, 1,400,000, and Santa Barbara 500,000 pounds. As our oil mills import flax seed largely, and the tendency of our people is to economy and the enlargement of our home industries, it may reasonably be expected that the cultivation of this plant will increase rapidly, and that the fiber, as well as the seed, will be utilized before many more years have gone by. The managers of the jute mill at Oakland having recently procured flax spinning machinery, with which they have made some excellent twine, are anxious to contract with flax growers for a quantity of the lint. The importations into the United States of the dressed fiber, and the linen made from it, amounted last year to $20,000,000, and yet no country is better adapted for growing flax than ours. While no crops of hemp have been raised in California, the experiments made with this textile plant demonstrate that our soil and climate are equally as well fitted for it as for flax, the stalk growing readily and yielding a strong and abundant fiber.

Jute and Ramie.—The attempts thus far made at cultivating ramie in California have been discouraging, the plant being liable to suffer from frost, and yielding but little fiber. The experiments made with jute, however, proved entirely successful, and there is little doubt but our tule lands, when reclaimed, will afford millions of acres well suited for growing this plant. Some trials made along the sloughs of the Sacramento have turned out extremely well. Growing jute on these tule lands and river bottoms would be attended with the further advantage of having water convenient for rotting the stalk. In view of the large demand for grain sacks on this coast, jute is sure to be grown here on an extended scale. It is estimated that our requirements for the present year, Oregon and Washington Territory included, will amount to over 45,000,000 sacks; which, making due allowance for sacks used a second time, would cost our farmers annually not less than $3,000,000. The principal hindrance to raising jute here is the fact that our cultivators would have to contend with the cheap labor of India, whence the entire supply of the world is at present derived. But as the home producer would have freights, duties, and insurance in his favor, it would look as if he ought to be able to compete successfully with the India grower, our soil and climate being probably as well adapted for raising the plant as his; not only so, but were our people to engage largely in the cultivation of jute, it may be presumed that we would soon invent machinery for dressing the stalk and preparing the lint for spinning, a process effected in India altogether by hand labor.

We have now two jute mills engaged in spinning this fiber and making the yarn into grain sacks, the one located at Oakland and the other at the San Quentin Prison, the latter being the property of the State. These mills, which employ from 400 to 500 hands each, are run to their full capacity for the greater part of the time, and turn out between 8,000,000 and 10,000,000 grain sacks per year, cotton sacks for flour, salt, etc., being also made at the Oakland mills. The sewing of these sacks is done partly by hand and partly with powerful machines constructed for the purpose and imported from Dundee, Scotland, where are located the most extensive jute factories in the world. The original cost of these machines, three in number, was $1,300 each—cost, delivered and set up here, $1,500. The output of the Oakland mill averages now about 5,000,000 grain sacks per year; of the San Quentin mill, about 4,000,000.

SUGAR—IMPORTATION, PRODUCTION, REFINERIES, ETC.

As yet California has done but little towards supplying herself with sugar, about all that has been accomplished in that direction being the production annually of less than 1,000 tons of sugar made from beets. The quantity of sugar beets raised in the State amounts to about 70,000 tons per year—40,000 tons raised in Alameda County, 20,000 in Los Angeles, and the remainder mostly in Sacramento County. There are four beet sugar factories in the State, one at each of the following places: Alvarado, Soquel, Sacramento City, and Isleton, the most of the sugar thus far produced having been made at Alvarado, in Alameda County. Some sugar cane has been raised in the southern part of the State and some sorghum elsewhere, but no sugar has been made from either, the first having been consumed by our cane-chewing population, and most of the sorghum used for fodder. As our soil and climate are exceedingly well adapted for the growth of the melon, it may be expected that a great deal of sugar will yet be produced here from that vegetable. Much has been said and written calculated to favor experiments with the melon sugar. Among those who have made valuable contributions to the literature of this industry, Wm. Wadsworth and Dr. J. S. Silver, of this city, are entitled to special mention. Extracts from these papers are given below. For refining the raw sugar imported into this State three large establishments have been erected in San Francisco, the most extensive of these, the California Sugar Refinery, lately completed, having cost over $1,000,000. These several establishments give employment to more than 500 hands, and use up every year over 120,000,000 pounds of raw sugar; value of products, $8,000,000 per year. Our imports of this article for 1883 were 103,932,158 pounds from the Sandwich Islands, and 20,183,301 from Manila, with some small lots from Central America and other sources. Our shipments of refined sugar east amounted last year to 32,576,080 pounds; shipments to foreign countries, 2,483,116 pounds.

CIGARS—MANUFACTURE, CONSUMPTION, ETC.

Although we raise but little tobacco in California, the business of manufacturing this article into cigars and other forms for use has reached here very large proportions, there being over 5,000 hands engaged in it, more than three fourths of them Chinamen. While the larger factories, all in San Francisco, are carried on by whites, many of the smaller are in the hands of the Chinese. Efforts have been made at various times to displace Chinese by white labor, but thus far without success. Some of the larger companies employ as many as 350 hands, and turn out over 6,000,000 cigars annually. The number of these articles made in the State last year amounted to 171,975,450, the entire quantity of tobacco worked up nearly 5,000,000 pounds, being valued at $10,700,000. In addition to the above 24,000,000 cigars were imported, some from Chicago and other places in the East and some from Cuba, with a few cheroots from Manila. We import nearly all our leaf tobacco from the Eastern States, the bulk of it coming from Connecticut and Pennsylvania. Some Mexican and Spanish manufacturers obtain their leaf from Havana. To foreign countries our exports in this line are small, though we supply cigars and cigarettes to all parts of the Pacific Coast, competing for this trade successfully eastward to the Missouri River. While the even temperature of our climate tends to improve the leaf, the products of our factories are said to be noted for their good appearance and finish. But for the prejudice entertained by certain classes of smokers against home-made articles generally, the importations of cigars would probably have ceased long before this.

As the price paid for making cigars is considerably less in San Francisco than in New York, we ship over 1,000 cases, mostly of cheap grades, every year to eastern markets; and when we succeed, as we ultimately will do, in raising our own leaf, the prospect is that a heavy trade will grow up in that quarter. Encouraged by war prices the cultivation of tobacco was undertaken in this State more than twenty years ago. Rich bottom lands having been selected the leaf first grown was too rank, and, having been badly cured, failed to meet with favor, though a very fair article of plug tobacco was made from it. Some plantings made afterwards, on more favorable soil, whereby the above defect was corrected, produced a leaf that served well for wrappers. Of late years but little tobacco has been grown in the State. The quantity raised in 1882, as reported by the Surveyor-General, was 26,590 pounds, grown on 27½ acres—25,000 pounds of this having been grown in Los Angeles County. Last year a lot of tobacco was raised near Colton, in San Bernardino County, which, though of a slightly pungent flavor, was much commended by the experts for its good qualities, having been pronounced equal to the best Virginia leaf in point of body and mildness. Despite some discouragements in the past the growing of this plant may be reckoned among the coming industries of California.

FISHERIES, SALMON CANNERIES, ETC.

The canning of salmon, though largely engaged in further north, is not an extensive industry in California, only twenty of the ninety canneries on the coast being in this State, the most of them located between Collinsville and Vallejo. Some of the fruit canneries in San Francisco also carry on the business of salmon canning, the season for the latter coming in before the fruit canning season becomes very active. The largest portion of the catch is made on the Columbia River, along the banks of which are located thirty-six canneries, which employ for taking the fish 1,600 boats, managed by two men each. The business is prosecuted on several other rivers in Washington Territory and Oregon, also on Fraser River, British Columbia, along which there are fourteen canneries. Some canning is done elsewhere in that country, also in Alaska, the fish taken in these northern waters being noted for their excellence. The entire pack of the coast amounted last year to 1,120,000 cases, the quantity salted and packed in barrels being equivalent to 60,000 cases more, the whole worth, at the rate of $25 per case, $5,600,000. The salt fish sell for about five cents per pound; after being smoked, for a little more. When the canneries have more fish than they can readily put up, and when retailers have more than they can sell, the surplus is salted. Fish caught out of season, or at localities where there are no canneries, are also disposed of in this way. We import salt mackerel, herring, etc., largely, but not much cod of late, our supply of this fish coming mostly from the North Pacific. The San Francisco market is well supplied with both salt and fresh water fish of almost every kind, some of the fish introduced into our waters, such as carp, shad, mackerel, etc., beginning now to make their appearance on the stands of the retail dealers. Our gourmands devour about 50,000 frogs every year, these amphibious creatures selling at the rate of $3 per dozen in San Francisco.

WIRE WORKS.

The wire mill and wire rope factory, under the same general management, and which may be said to constitute one establishment, are situated in the northern part of the City of San Francisco. At the former, wire of all sizes and every description is drawn from copper, brass, iron, crucible and Bessemer steel. At the factory the products of this mill are wrought into every style of article made of wire or into the manufacture of which it largely enters, such as rope, cloth, cables (round and flat), barbed wire for fencing, screens, fenders, trellis-work, chairs, sofas, baskets, bird cages, etc. Some very heavy work has been turned out at this establishment. Here was made last year the cable now in use on the Market Street Railroad, 22,000 feet long, one and five sixteenths of an inch thick, and weighing nearly 60,000 pounds. The cables in use on our other street railroads, also most of those placed in the hoisting works on the Comstock Lode, came from this factory. Connected with these works, which are very extensive and complete, are a galvanizing department, machine shop, foundry, etc. They employ a total of 100 men and 15 boys. The sum paid out for wages here amounts to $120,000 per year; value of products made, $400,000.

THE PACIFIC SAW COMPANY

Manufacture at their works in San Francisco saws of every description, the making of circular, gang, and crosscut saws constituting, however, the bulk of their business. This enterprise, started in 1866 with a capital of $24,000, all invested in stock, tools, and machinery, has proved a marked success, owing to the excellence of the wares turned out by the company, who employ 30 men at wages ranging from $2 to $6 per day, and produce goods to the value of $110,000 annually. The circular saws of this company are in use all over the coast to the almost entire exclusion of every other. They also supply these articles to the west coast of Mexico, Central and South America, and even send some into the regions east of the Rocky Mountains. Although this company have heretofore procured most of their steel from Pittsburgh and Sheffield, the probabilities are that they will hereafter make use of the home-made article. By reason of this establishment importations of saws into California have been greatly diminished, amounting of late to hardly more than 2,000 dozen hand and 1,000 dozen crosscut saws per annum.

CORDAGE.

There have been two cordage factories started in California, the one by the San Francisco and the other by the Pacific Cordage Company. The works of the former, erected by the Messrs. Tubbs in 1856, are located at the Potrero, in the southern part of the city. The works of the Pacific Company, erected in 1877, are located at Melrose, in Alameda County; when running, the latter employed 90 hands, and had capacity to turn out 2,000 tons of rope per year. The sounding-lines used in making surveys for the Pacific Ocean Telegraph Cable, some of which were ten miles in length, were manufactured here. It having been found that the two factories were turning out wares greatly in excess of trade requirements, operations at Melrose were suspended, as a means of averting what otherwise would have proved a ruinous over-production. The Potrero establishment, having since been run to its maximum capacity, has worked up raw material at the rate of 6,000 tons per year, the rope made amounting to 20 tons daily. This factory employs 150 men, at wages said to be seventy-five per cent higher than are paid in Europe, and turns out products to the value of $750,000 yearly. The fiber used here consists of Manila hemp and sisal from Yucatan, nearly every kind of cordage, from the heaviest ship hawsers to hay rope, being manufactured, all of a quality equal to the best imported. More than a third of all the rope made here is used by the farmers for baling hay, binding grain, etc., much being also required for hoisting purposes in the mines, repairing the rigging of ships, etc. Our imports of cordage during the past two years have been as follows: 1882, 4,058,410 pounds; 1883, 1,676,941 pounds; the quantity imported having been greater in 1882 than for many preceding years. Our exports in this line are inconsiderable.

A small factory at Portland, Oregon, supplies that State with cordage, at least, in part.

HOSE AND BELTING.

There are four factories on this coast, all in San Francisco, engaged in making hose and belting. They give employment to 45 hands, and turn out annually about 200,000 feet of leather belting, 7,000 feet of hose, and 180,000 feet of lacing, of the total value of $260,000. Our exports in this line are small, not over $50,000 worth per year, the magnitude of our mining operations and the extent to which hand irrigation is practiced here, causing a large consumption of this class of goods. Of leather hose and belting, we import but little, the products of our home factories being greatly superior to anything we are able to obtain abroad. Our importations of rubber belting and hose are, however, heavy, their value approximating $800,000 yearly. The industry under consideration has been with us a very prosperous one and is likely so to continue. Commenced in 1857, it has grown slowly but steadily ever since, the great excellence of California tanned leather having contributed largely to its success.

HARNESS, SADDLERY, WHIPS, ETC.

By reason of the much teaming, staging, packing, and riding that in this State became necessary, the manufacture of harness, saddles, etc., commencing here at an early day, grew speedily into a large and profitable business, few industries in California having paid better than this. Even before the American occupation of the country, the riding accouterments of the native Californian had become noted for their excellence. With those who ride much, the Spanish saddle is still preferred to the English, to which it is, in fact, greatly superior, both as regards durability, comfort, and safety. Owing to the severe service required of it, our workmen have been trained to make only harness of the best kind; hence, for these equipments, we have had the entire market west of the Rocky Mountains. It has also been our custom to export yearly about $75,000 worth of heavy harness and Spanish saddles to the Sandwich Islands, to be used mostly on the sugar plantations there. Our annual expenditure abroad, for this class of goods, does not exceed $75,000, mostly made for fine harness, side-saddles, etc. About $15,000 worth of these goods are imported from England, the rest from the Eastern States. Nearly everything in this line is made of California tanned leather, only a little harness leather of extra fine quality being imported. There are no very extensive manufactories of these articles in California, the business being carried on mostly in small shops all over the country. There are probably in the State 800 men employed at this business, the value of the goods manufactured amounting annually to about $2,000,000—

money paid out for wages, $400,000, workmen being paid from $2 to $3 50 per day.

At some of the harness shops a few whips are made, there being but one factory on the coast, that of Keystone Brothers, San Francisco, devoted exclusively to that business. This firm employs about a dozen hands, and manufactures reatas, headstalls, Mexican bridle reins, etc., to the value of $25,000 a year. The value of the whips manufactured in the State, amounts to about $30,000 per year, with nearly as many more imported. The latter consist mostly of carriage and buggy whips, which, though of more stylish appearance, do not wear as well as the home made article. Most of the materials used in this business, such as leather, rattan, whalebone, glue, etc., are of domestic production.

CATALOGUE AND DESCRIPTION

OF THE

MINERALS OF CALIFORNIA

AS FAR AS KNOWN,

WITH SPECIAL REFERENCE TO THOSE HAVING AN ECONOMIC VALUE.

ALPHABETICALLY ARRANGED.

INTRODUCTION.

Before entering upon a description of the minerals that occur in California, it may be proper to note the changes that have taken place in our industrial affairs, also the altered conditions of labor and capital, and explain how it is that these valuable products have been so little utilized, lest such neglect be construed to mean that the State is deficient in resources of this kind, than which nothing could be more erroneous.

The principal obstacle in the way of our turning these forms of our natural wealth to practical account, has been the high prices of capital and labor that for a long time obtained here, rendering it cheaper to import such commodities as we required in this line of consumption than to produce them at home, even though we had the raw material in abundance. For many years these two prime factors of production were from three to five times as dear in California as in most other countries. In 1848–9 common labor commanded here from $10 to $12 per day; and, although the price declined in the course of three or four years to less than half these rates, and afterwards underwent a still further reduction, it remains still from fifteen to twenty per cent higher than in the northern Atlantic States, the wages of mechanics, miners, and artisans, being here proportionately higher than those of farm hands and other unskilled laborers. As with labor, so with capital—money, while it commands no longer the excessive rates of interest formerly obtained for its use, is still from twenty to twenty-five per cent higher here than in the States east of the Missouri River. Meantime, while these elements of production remained so much higher than in any other part of the world, ships in great numbers began to come here to load with wheat, bringing iron, salt, sulphur, cement, glass and earthenware, fire bricks, and such other articles as suffer little harm from a long sea voyage, at low rates of freight—sometimes as ballast. If, after this wheat traffic had reached large proportions, inaugurating an era of low freights, the local demand for any of these commodities happened to be such as seemed likely to encourage their manufacture being undertaken here, straightway the importer and the foreign producer combined to flood the market, or by other means managed to so depress prices as to prevent the contemplated enterprise being engaged in, or to crush it out if already undertaken. And thus, for a time, were residents of California deterred from trying to produce this class of articles at home, well knowing that they would be forced to struggle against a ruinous competition if they sought to do so. And, then, not always at first could such skilled labor be commanded here as was required for the successful prosecution of these new industries, few trained artisans or handicraftsmen caring to come to a country so remote and offering so little chance for steady employment.

Besides these more general there existed diverse minor hindrances to the establishment and growth of these special pursuits in this State, such as restricted consumption, sudden fluctuation in prices, cost of fuels, and sometimes too much home competition, a number of enterprises of this kind having come to grief through excessive local rivalry coupled with a limited market. Over-production has, in fact, proved disastrous to two or three of our domestic industries, and something of a detriment to several others. The production of more borax and quicksilver than the markets of the world could absorb has diminished the profits of these pursuits to a minimum. The facility with which salt can be made on this coast, combined with heavy importations, have reduced this business to nearly the same condition. Other cases of like purport might be cited.

Sharp vicissitudes in prices have not been so common of late years as formerly, when, nearly everything being imported, and being often a long time on the way, an unexpected scarcity might easily occur, and when, also, it was comparatively an easy thing to effect corners in the market. The want of a cheap smelting and coking coal has been a serious and ever present obstacle to the growth of the iron interest, also to the reduction of certain ores, as well as the manufacture of glass, earthenware, and many other articles.

But the most of these adverse conditions having disappeared or been so modified that they are no longer formidable, many of these useful products of nature are destined to be made industrially and commercially available in the near future, a good deal having already been accomplished in that direction. If labor in California is a little dearer than in the older States of the Union, it is nevertheless in good supply and generally disposed to act in harmony with capital, nor is there much reason to apprehend that any serious conflict will soon arise between these producing forces. The working classes, by reason of the healthfulness of the climate and the cheapness of the staples of subsistence, perform their tasks with such comparative comfort that we have here less insubordination and complaint than is common in most other countries. What adds to the general contentment is the extent to which the migratory spirit incident to the gold-mining era has given place to proclivities of an opposite tendency, the inhabitants of California, from being the most nomadic of all peoples, being noted now for their stability and love of home. Hence it has come to pass that the State is being populated by a race that can be depended upon, in so far, at least, as fixity of residence is concerned. Out of this disposition to abide in one place there has grown a necessity for the on-coming generation to make the most of their local resources; wherefore, a variety of metals and minerals are beginning to be sought after, which, in earlier times, received little attention or were wholly overlooked.

While the precious metals continue to hold, as they long must hold, a prominent place in the mining industries of California, coal, iron, copper, chromium, mica, antimony, asbestus, the useful clays and mineral fertilizers, cement, lime, gypsum, and the like, are every year becoming more and more the objects of research and enterprise, nor is there any doubt but these substances, so long regarded as of secondary importance, will, in the end, do more to advance the permanent interests of the State, and otherwise prove of greater intrinsic value than gold or silver. And, certain it is, no people ever have or ever can become rich, prosperous, and progressive, who confine themselves to a narrow field of industry, the impolicy of such a course being well illustrated by the backward condition of Russia, Spain, Egypt, Mexico, and nearly all the republics of Central and South America. Owing in a great measure to this cause, so long as the Southern States raised only cotton and sugar, many of the inhabitants remained ignorant and impoverished, the tendency in every country where but a single or a few staple articles are produced being to divide the population into two classes, the proprietary and the servile—the rich and the poor. Were California to produce nothing but wheat, wool, wine, and gold, she would still be wanting in the best elements of the higher civilization, no matter how much of these valuable commodities she might be able to grow or gather every year. Our people enjoy a larger aggregate of physical comforts, and are every way better off now than when gold mining constituted their principal and almost sole employment—varied pursuits are a great equalizer of rank and distributor of riches. Things made at home, besides giving employment to labor, retain in the country the money it would cost to obtain them abroad.

But while a system of diversified industries is so essential to the well being of every community, the establishment of such a system is a work of time, and requires to be gone about with deliberation and caution; we of California having in numerous instances engaged in mining and manufacturing enterprises prematurely or without taking those precautions that ordinary prudence and business sense would naturally suggest. Hence the considerable number of failures that has attended these undertakings, scarcely any of which have caused disappointment except where so unadvisedly entered upon. One prolific source of disaster to ventures of this kind has been the misleading character of the reports emanating from prospectors and claim locators, vouched for and very often amplified by the local press. Relying on this sort of authority a great deal of money has, one time and another, been wasted in searching for ore where little or none existed, such expenditures being sometimes supplemented by others for reduction works where, of course, none were needed. The prospector for mineral deposits is apt to be of an ardent and hopeful temperament. But for those mental idiosyncracies he would not be likely to engage in the business. Being so constituted he becomes often the victim of the grossest self-deception, and is thus prepared to honestly deceive others. What to a less sanguine person might seem hardly an encouraging indication is to him proof positive. Others, confiding in his statements, are exposed to disappointment. As the losses resulting from these mistakes do not always fall on the parties causing them, their occurrence is much to be deplored. Besides the damage inflicted on those more directly concerned, they react unfavorably on the business of mining and manufacturing generally, their tendency being to discourage exploration, and deter capitalists and others from embarking in legitimate undertakings.

It is useless to claim for California forms of mineral wealth that she does not possess, nor can any good come from encouraging others to engage in any pursuit prematurely, or without their having first carefully canvassed the chances for success. Our past experience admonishes us to avoid precipitate action in matters of this kind. One fourth of the quartz mills and smelters put up in the mines are idle, and in the suburbs of many a mining town in the State may be seen deserted reduction works, refineries, and factories of various kinds, some because they were attempted to be operated by processes inherently defective, but more because of an insufficient supply of ore or other material to keep them profitably employed. The cement mills near Benicia have been idle for years. The small antimony works put up in San Francisco can be run but part of the time through lack of ore, the larger establishment of this kind erected in West Oakland having, for the same reason, succumbed some time ago, and yet, to read the published accounts of our antimony deposits, it would be supposed that we had enough ore of this sort to supply the wants of the entire world. The same thing was being said a few years since about our cement beds, which it was claimed were of the best quality, yet the experiment proved a failure, consumers preferring the imported article. We have, it is said, sand suitable for making the finer kinds of glass, and yet our glass makers are perverse enough to go all the way to Belgium for this material. We have no doubt good clays in California, and yet we do not keep out the English fire-bricks. These remarks are not made with a view to disparage our mineral resources, or to discourage their development, but for the purpose of emphasizing the importance of greater caution, both in the inauguration and subsequent conduct of mining and other industrial enterprises. It has been our purpose to embody in this report none but information of a reliable character. In the absence of pecuniary means to visit and examine more than a few of the many mineral deposits reported, the State Mineralogist has been compelled to accept second hand certain information in regard to the character and value of these deposits, giving the same for what it is worth. It is not, therefore, expected that the data here supplied will alone suffice as a safe basis for important industrial enterprises and business transactions. Where these are contemplated, further inquiry should be made, and in so far as possible, more full and reliable information be obtained. The principal object of this report, pointing out where the more valuable minerals occur, and the extent to which they have been recovered from nature and converted into useful forms, has, however, it is hoped, been reasonably attained.

It may here be explained that this report, being designed for the non-professional reader, rather than the skilled scientist, has been prepared with special reference to the wants of the class for whom it is mainly intended. The various subjects discussed have, therefore, sometimes been treated with an amplitude that, to the trained expert and such as have always access to authorities, may seem prolix and even superfluous. The controlling idea in the preparation of this paper has been to furnish the manufacturer, mechanic, and artisan such information as will be of service to them in the prosecution of their several callings, and to supply the prospector and miner with plain rules by which they will be able to recognize most ores and minerals found in this State, and to employ simple tests for their determination, when this cannot be done by the eye. If the skilled chemist, mineralogist, and assayer, and such others as have had the benefit of a technical education, may not much feel the need of this sort of information, it is still hoped that the classes for whom it was more particularly intended will derive from this paper some benefit, and that even the millman and practical metallurgist will find in it hints that may prove serviceable to them in their difficult vocations.

It has been thought best to reprint in this report certain parts of former ones bearing specially on the minerals of the State, both to save the labor of rewriting and because editions of the first reports have long since been distributed and are not always attainable for reference.

CALIFORNIA MINERALS.

ACTINOLITE—see Amphibole.

1. AGALMAMOLITE. Etym. "*An Image*" (Greek). PAGODITE—from *Pagoda* (Chinese). Chinese figure stone, a variety of pinite, hydrous silicate of alumina, magnesia, iron, lime, soda, and potash.

It is much used for ornamental carved work by the Chinese. A number of specimens from that country appear in the State Museum. No. (4060) in the Catalogue, from San Luis Obispo County, much resembles this mineral, as does also (5300), from Greenwood, El Dorado County, which occurs in a vein from six inches to a foot in thickness. These specimens have been so labeled with an interrogation, pending an analysis, when the State Mining Bureau has a suitable laboratory.

AGATE—see Quartz.

ALABASTER—see Gypsum.

2. ALBITE. Soda Feldspar. Etym. *Albus* (white), from its color.

It is, when pure, a silicate of alumina and soda, as follows:

Silica	68.6
Alumina	19.6
Soda	11.8
	100.0

Part of the soda is sometimes replaced by potash and other elements and compounds, as lime, magnesia, etc. There are numerous varieties of Albite under different mineralogical names. The true Albite has not been found in California, in distinct masses, as far as my experience goes. Dana gives as a locality the vicinity of the Murchie mine, Calaveras County, with gold and pyrite.

The crystalline and plutonic rocks of California have not been studied as they should be, but an abundance of soda, resulting, probably, from their decomposition, would seem to indicate that Albite, in some form, enters largely into their composition.

3. ALTAITE. Etym. *Altai mountains of Asia.* Telluride of Lead.

Has the following composition:

Lead	61.7
Tellurium	38.3
	100.0

Color, that of metallic antimony with a shade of yellow—luster metallic H. 3—3.5, sp. gr. 8.2, on ch. in R. F., colors the flame blue, entirely volatile when pure, but leaving in some cases a trace of silver. The ch. becomes coated with telluride of lead and litharge. The former with metallic luster, and the latter yellow and dull. As tellurium minerals are rather common in California, the most important and interesting facts concerning this rare element will be given under the head of "Tellurium," with tests for its determination.

Altaite is said to be found at the Rawhide Ranch gold mine, Tuolumne County, in small quantities, but as no analysis has been published, there is some doubt as to its identity. It has lately been reported at the Frenchwood mine, Robinson's Ferry, Calaveras County, according to Z. A. Willard, with Petzite, Calaverite, and other tellurium minerals, and gold; also at the Morgan mine, Carson Hill, Calaveras County, in large masses, with gold, and at the Adelaide mine, in Tuolumne County. Dana gives the Golden Rule mine, Tuolumne County, as a locality.

4. ALUM. Etym. "*Alumen*" (Latin), as generally understood, is a hydrous sulphate of alumina and potash, as follows:

Sulphate of alumina	36.2
Sulphate of potash	18.3
Water	45.5
	100.0

It is produced artificially by adding the deficient elements to the leachings of calcined alum shales. When natural, the mineral is called *Kalinite*.

When ammonia replaces potash, the mineral is Tschermigite. These minerals and soda alum, or Mendozite, resemble each other in taste and appearance. There are several localities in the State where native alum has been found, but the minerals have not been analyzed, for which reason their exact composition is uncertain. It has been found as an incrustation ten miles north of Santa Rosa (4468), near Newhall, Los Angeles County (4404). Alum slate occurs near Auburn, Placer County (4249), and (4250) is alum crystallized from it. Alum in thick incrustations has been discovered at the Sulphur Bank, Lake County, in considerable quantity (1108), at which locality other sulphates are abundant. This mineral is thought to be Tschermigite, but no analysis has been made to prove it.

Alum is said to occur at Silver Mountain, Alpine County, on Howell Mountain, Napa County, and at numerous localities, as an incrustation on certain rocks. I have seen it crystallized on the bare rocks washed by hydraulic streams in gold mines near Dutch Flat, in Placer County, and in Nevada County. When all conditions are favorable in the State, alum will perhaps be largely produced, and there seems to be no reason why it should not be.

AMIANTHUS—see Amphibole.

5. AMPHIBOLE. Etym. "*Doubtful*" (Greek). Actinolite, Anthophyllite, Amianthus, Asbestus, Hornblende, Mountain Cork, Mountain Leather, Tremolite, etc.

Amphibole is an anhydrous silicate of various bases—iron, magnesia, lime, etc.—generally containing a little water.

ACTINOLITE (Ray stone) is rather abundant in the counties bordering on the Bay of San Francisco. It is found in bowlders, or rolled masses, in Alameda and Contra Costa Counties, which, when broken, show beautiful green radiating crystals. It is found in some rocks of the Coast Range, near Knight's Ferry, Stanislaus County; also at Petaluma, Sonoma County, with garnets (Blake); on the Mariposa estate, Mariposa County, in fine needle crystals; and in quartz, Eagle Gulch, Plumas County (Edman). The following specimeus may be seen in the State Mining Bureau: (3431) twelve miles from Gilroy, Santa Clara County; (4213) Eureka, Humboldt County; (4335) Santa Rosa, Sonoma County; (4339) Spanish Ranch, Plumas County.

Although this mineral is very interesting to science, and is found in beautiful cabiuet specimens, it has no economic value.

ANTHOPHYLLITE, named from its clove brown color, is said to be found at Slate Range, San Bernardino County.

ASBESTUS, *Amianthus*, is named from Greek words, meaning incombustible. It occurs in long fibrous masses, which are silky in appearance. The fibers in the best quality can be separated and twisted into threads, which may be woven into cloth. This mineral was well known to the ancients, who utilized it in numerous ways. The wealthy Romans are said to have used the cloth for napkins, which each took to banquets for personal use. When soiled the napkins were thrown in a fire, and burned white and clean. The following is a quotation from Pliny's Natural History, Book 19, Chapter 4:

> There has been invented, also, a kind of linen which is incombustible by flame. It is generally known as "live linen," and I have seen before now napkins that were made of it thrown into a blazing fire in the room, where the guests were at table, and after the stains were burned out, came forth from the flames whiter and cleaner than they could possibly have been rendered by the aid of water. It is from this material that the corpse cloths of monarchs are made, to insure the separation of the ashes of the body from those of the pile. This substance grows in the deserts of India, scorched by the burning rays of the sun. Where no rain is ever known to fall, and amid multitudes of deadly serpents, it becomes habituated to resist the action of fire. Rarely to be found, it presents considerable difficulty in weaving it into a tissue, in consequence of its shortness. Its color is naturally red, and it only becomes white through the agency of fire. By those who find it, it is sold at prices equal to those given for the finest pearls. By the Greeks it is called "Asbestinon," a name which indicates its peculiar properties.

Asbestus has been found at numerous localities in California, the best quality being from Butte County, eighteen miles north of Oroville. (1677, 1678, 1842) are specimens from this locality. The fibers are long and fine, quite equal to the best Italian. It is found also in Del Norte County, Salt Spring Valley, Calaveras County, Los Angeles County in large masses (Blake), Jenny Lind Hill (Trask), San Diego County, near Caliente, San Bernardino County, Key's Tunnel, California Mine, Yolo County (449), Shasta County (1293), White River, Tulare County (2419), Mount Bullion, Mariposa County (2437), Bear Valley, Mariposa County (4464), in the Inyo Mountains, Inyo County, and elsewhere in the State. At least one company has been organized to work asbestus deposits in California. The United Asbestus Manufacturing Company was incorporated June 22, 1883, for the purpose of manufacturing, selling, and dealing in asbestus. Their mine is in Placer County. The Swiss Boys and Leeds claims are on the right bank of the American River, one mile below Rice's Bridge. The following recently appeared in the Fresno Republican:

> W. P. Litten and B. Greenley, of Grub Gulch, called at the Republican Office, and exhibited specimens of asbestus taken from ledges recently discovered in French Gulch, in the Potter

Ridge mining district. The specimens shown us appear to be a fine article, and the gentlemen claim for it that it is equal to the best quality used for manufacturing purposes. They are of the opinion that this valuable mineral exists in paying quantities, and as soon as this fact is thoroughly demonstrated the attention of capital will be enlisted and this new source of mineral wealth developed.

The uses of Asbestus are various, which, however, may be, briefly stated, for paints, coating for boilers and steam pipes, indestructible lamp wicks, packing for steam engine cylinders, roofing, filling fire-proof safes, boards for flange joints, etc.

It is as yet uncertain how extensive the deposits of California may prove to be. There is a demand in the world for all that is likely to be produced, and the manufacture is in the hands of a few, who, to a certain extent, dictate prices. Fifty dollars per ton has been offered for asbestus of good quality and long fiber; for an inferior quality $25 only can be obtained; the price in New York is from $15 to $60, according to quality. The finest Italian commands from $100 to $250 per ton, governed by quality and the state of the market.

HORNBLENDE—From *Horn and Blende* (German) enters into the composition of many of the rocks, as syenite, diorite, gneiss, porphyry, etc., and it sometimes is found in rock masses. It has no economic value except as a building stone. It is found in California at San Pablo, at Soledad, and at Vallecito; near Murphy's, Calaveras County (Blake), at Gold Run, Placer County (4266), Healdsburg, Sonoma County (2263), Folsom, Sacramento County (2913), and as a constituent of certain rocks over a large area of the State.

MOUNTAIN CORK, so named from its resemblance to cork, is found in Tuolumne County (Blake). It has no value in the arts.

MOUNTAIN LEATHER, a similar mineral, has been found in Tuolumne and Mariposa Counties, and at the Little Grass Valley mine, Pine Grove district, Amador County (4336, 4727).

TREMOLITE, named from Tremola, a valley in the Alps, where it was first discovered, is found white and fibrous in limestone, in Columbia, Tuolumne County (Blake), Santa Cruz Mountains, Santa Cruz County (2129).

6. ANDALUSITE. Named from Andalusia, a province in Spain, where it was first found, is a silicate of alumina, containing sometimes sesquioxide of iron, magnesia, lime, soda, potash, and manganese in varying proportions. When pure it has the following composition:

Silica	36.8
Alumina	63.2
	100.0

The California mineral is known in mineralogy as Macle, or *Chiastolite*, from the markings and the forms of the crystals; the former name is from the Latin *Macula* (a spot), and the latter from the Greek letter X.

Andalusite is found in large quantities in the slates cut by the Chowchilla River, near the old road to Fort Miller, Fresno County, and in the conglomerate which caps the hills; in the slates at Hornitos, in Mariposa County; at Moore's Hill, Mariposa County; twelve miles south of Mariposa; at Moore's Flat, same county; near Ne Plus Ultra mine, Fresno County.

In the State Museum (4450) is a piece of clay slate, with Andalusite crystals imbedded. Some of the crystals are five inches long, and from one half inch to an inch thick. This mineral is known to the miners as "petrified nails." The ends of the crystals show the characteristic markings and crosses peculiar to the species; these are much better seen when transverse sections are cut and mounted for the microscope. Few objects have the rare beauty of this mineral, when well prepared and examined with a two-thirds objective and lighted with an achromatic condenser or parabola.

Several sections now in the State Museum, cut by Mr. Melville Attwood, of San Francisco, were exhibited at the Paris Exhibition of 1878, and attracted considerable attention. The nebulous cloud of black particles, as seen under the microscope, strongly resemble magnetite in slices of basaltic rocks seen under the same circumstances. This mineral has no economic value.

ANDRADITE—see Garnet.

7. ANGLESITE. Etym. "*Anglesea*," an island on the coast of Wales.

Is a natural sulphate of lead, called also "lead vitriol." Composition (PbO, SO_3):

Sulphuric acid	26.4
Oxide of lead	73.6
	100.0

H. 2.75—3, sp. gr. 6.12—6.39, occurs in transparent crystals and amorphous.

Anglesite may be distinguished by the following reactions: B. B. on ch. it fuses easily and is reduced to a sulphide; at this stage a small portion removed from the charcoal, placed on a clean silver coin and wet with water will produce a black spot which cannot be removed without considerable rubbing. On ch. if the R. F. is continued for some time, with addition of soda, a globule of lead is obtained and the ch. is coated yellow. If the lead is afterwards cupelled, a button of silver is generally obtained if the specimen was amorphous.

It is rather a common mineral in California, and exceptionally so at the Cerro Gordo mines, Inyo County, where it assumes a compact form, unlike any described variety found elsewhere. These deposits have been extensively mined for lead and silver; and although the shafts have attained considerable depth, no water has been met with, even in the lowest workings.

Anglesite is found in these mines in large masses, and in nodules inclosing Galena, from which it is evidently a pseudomorph. When these masses are broken the Anglesite is frequently found in concentric shells of different colors, like agate. Large crystals are uncommon; but a microscopic examination of freshly broken surfaces will often reveal crusts of exquisite transparent Anglesite crystals, associated with other lead minerals.

Anglesite in California is a valuable and abundant ore of lead, often very rich in silver, and always carrying a notable portion of that metal. It is found, also (1648, 1668), with Bindheimite, Azurite, and Galena, at the Modoc mine, Inyo County; with Galena at the Cerro Gordo mines, Inyo County; with Argentiferous Galena, at the Santa

Maria mine, Cerro Gordo, Inyo County, and at the Eclipse mine, in the same county, with Azurite and Galena.

8. ANHYDRITE. Etym. "*Without Water*" (Greek). Anhydrous Sulphate of Lime, Anhydrous Gypsum.

Color generally white; sometimes gray, blue, or red. H. 3–3.5, sp. gr. 2.9–2.98. Composition:

Lime	41.2
Sulphuric acid	58.8
	100.0

It is slightly soluble in water, and when exposed to the action of the elements it slowly changes to Gypsum. It would, therefore, be useful as a fertilizer, but it cannot be used in the manufacture of plaster of Paris. This mineral is not common in California; the only locality known to me is near Anaheim, Los Angeles County. The mineral is white, semi-crystalline, translucent, resembling crystalline marble, and could be made a beautiful ornamental stone. Dana, in his California Mineral Localities, gives near Santa Maria River, Los Angeles County; this may be the same as above.

Anhydrous Sulphate of Soda—see Thenardite.

Anthracite—see Mineral Coal.

Antimony—see Cervantite and Stibnite.

Antimony Ochre—see Cervantite.

Antimony Sulphide—see Stibnite.

9. ARAGONITE. Etym. *Aragon*, a province in Spain. See, also, Marble, under the head of Calcite.

When pure it has the following composition:

Carbonic acid	44.
Lime	56.
	100.

It is not uncommon in California. It is most frequently found as a deposit by mineral springs. It occurs, also, in the underground workings of gold and silver mines, and often forms in abandoned tunnels and shafts.

The so called California Onyx Marble is found in many beautiful varieties. The prevailing colors are various shades of orange on a delicate cream colored, and in some cases bluish ground. When cut and highly polished the chromatic effect is very striking. Large slabs cannot be obtained, owing to the nature of the deposit; and it is necessary to make up the surface required by piecing. It is coming into general use in California as an ornamental stone. It much resembles a mineral found in Mexico, and also misnamed "Mexican Onyx," of which magnificent specimens were shown at the Paris Exposition of 1878. California specimens, also exhibited, were small, but attracted much attention, their beauty and variety being the subject of remark by those who were specially interested in marbles.

The variety known as "Suisun Marble," and named from the locality at which it is found, received a share of notice and attention. A Californian at Paris stated, with evident pride, that he had seen a small slab at the Vatican, in Rome, in a collection of rare marbles, and that it was prized as being amongst the rarest and most beautiful of them all. The quarry from which this elegant ornamental stone is obtained lies in a low hill near the Town of Suisun, Solano County. The mineral has been somewhat extensively mined. No large pieces have been found of even texture suitable for working, which is a drawback to its usefulness, while that circumstance adds to its rarity and value. The deposit is evidently of aqueous origin. There are calcareous springs in the vicinity, which are now depositing tufa. Similar ones must have existed in former times of greater magnitude, which did stupendous work, and then, from some unknown cause, diminished to small and insignificant size. The varieties of this marble are so great as to be considered endless. The prevailing colors are red and yellow, in countless shades and tints. It is sometimes banded like agate, often showing stripes and bands of carnelian color, white and nearly black, like sardonyx.

The following analysis of Onyx Marble was made in the laboratory of the State Mining Bureau, by Edward Booth, in 1880:

Silica	.02
Ferric oxide	.07
Magnesia	.50
Lime	55.94
Carbonic acid	43.96
	100.49

Attempts have been made to burn it for lime, but probably with indifferent success, for it has been discontinued. Aragonite does not make good lime, owing to its property of falling to a powder when strongly heated.

Onyx Marble was known to the ancients; it was used in Rome and Carthage, and was known as Oriental Alabaster. The quarries were rediscovered in 1849, in Egypt, by M. Delmonte. It is now employed in Paris and elsewhere for ornamental works, such as bases for clocks, vases, etc.

The following localities are represented in the State Museum: (2.) Onyx Marble (red), Suisun. (261.) Onyx Marble (orange), Suisun. (556.) Onyx Marble (variegated), Suisun. (575.) Onyx Marble, San Luis Obispo. (1194.) From Gold Run, Placer County. (1872.) Deposited from a mineral spring—Soda Springs Hotel, Siskiyou County, near the falls, and near the Sacramento River. (2006.) Onyx Marble, southeast quarter section nine, township thirty-two south, range fifteen east, Mount Diablo meridian, similar to (575). Mr. J. Z. Davis has placed a mantel of this beautiful mineral in the Museum as a loan. The prevailing colors are orange and blue. It is not only a representation of one of the most beautiful ornamental stones in the State, but is a credit to the workmen who cut it. It is wholly a California production, and one of which the State may be proud. (2327.) Onyx Marble, deposited by a mineral spring six miles from Kernville, Kern County. (2740.) Aragonite, in beautiful snow-white crystals, found in the Candace Copper mine, Colusa County. (3602.) White Saccharoidal Aragonite, is easily reduced to a powder, and may perhaps be used as a substitute for chalk in chemical manufactories—it occurs in large quantities, deposit said to be four hundred feet thick—some attempts have been made to burn it for lime. (3733.) From Cerro Gordo, Inyo County. (4758.) From the ranch of J. M. Pugh, near Smithville, Colusa County. (5220.) Onyx Marble, near Yreka, Siskiyou County. A specimen of Yellow Aragonite was exhibited at the Paris Exposition of 1878 from Alpine County—it formed in a sluice box to the thickness of an inch—the impression of the grain of the wood was so perfect that the mineral looked on one surface like wood itself. It is a common thing for iron water-pipes laid in the Colorado desert to become choked by an accumulation of Aragonite. (2264) is a section of two-inch pipe which lay at Frink's Spring, on the Colorado desert, for two years—the pipe is nearly full—an analysis shows the mineral to be aragonite, with magnesia, sulphate of lime, oxide of iron, and silica as impurities.

A new locality of Onyx Marble has lately been found in Solano County, near Suisun, of which there is in the Museum a polished specimen. The following is from the San Luis Obispo Tribune of January 19, 1884:

ONYX.

The beautiful onyx found in San Luis Obispo County is a neglected jewel. Considerable of it has been mined and manufactured in San Francisco into ornaments, and although the material is as rich and elegant as anything conceivable, it is not yet fashionable. Governor Stanford has a very little in his house. The Chronicle office has a counter, and Captain Thompson, a millionaire resident of Alameda, has a fireplace, mantel, jamb, hearth, and other work of it, and these with a few offices in San Francisco, are about the extent of the use of onyx. The mantel in the Mining Bureau, of San Luis Obispo onyx, called the handsomest thing on exhibition, ought to draw attention to the substance. The objection is that it is a home product, and has not yet become fashionable. The newly rich people of San Francisco, and there are many of them, are not content with anything unless it has a foreign label on it. Their wine must have a French name, their marbles must be from Italy, and their ornaments such as the rich of the East have adopted as the fashion.

Onyx Marble is not only rare, but it is not apt to be found in large quantities in any one place. Owing to the peculiar manner in which it is liable to fracture, great care has to be observed in quarrying it. Powder cannot be employed for breaking it out; this has to be effected wholly by "wedging." And when quarried and furnished to the artist's hands care is still required in working it into shape, because of its fine texture. As it occurs in irregular masses, adhering to the inclosing rock, usually a sandstone, there remains generally a good deal of the latter attached to it when it is broken out. Seen as it comes from the quarry, this mineral has a rough, nodular appearance, suggesting the probability of its having been deposited by water holding lime in solution. From what has been said it will naturally be inferred that articles made from a mineral so scarce, so hard to quarry, and so difficult to shape, are somewhat expensive, and the inference is warranted by the prices these articles command the world over. A mantel-piece, for example, sells readily for $500, and other things in proportion. Such being the case, it is not to be expected that a mantel of this kind will be set up in every man's house, nor that our public fountains will just yet be chiseled out of this sort of material; nevertheless, now that we have this stone of such great excellence here in our own State, it may be expected that people of abundant means and cultured tastes will largely employ it for the adornment of their mansions, and the enrichment of their art treasures. Those who wish to see this new glory among California minerals can do so by visiting the State Mining Bureau, where it can be seen polished and wrought into elegant shapes, and also in its native roughness.

Aragonite has been found at the New Almaden mine, Santa Clara County (Dana).

ARAGOTITE—see Petroleum.

ARENACEOUS LIMESTONE—see Calcite.

10. ARGENTITE. Etym. "*Argentum*" (Latin name for silver). Silver Glance. Vitreous Silver. Sulphuret of Silver (Ag. S.)

Silver	87.1
Sulphur	12.9
	100.0

Color and streak, dark lead, gray, opaque; H.=2.25, sp. gr.=7.2—7.3; luster, metallic; B. B. on ch. melts easily, with strong smell of burning sulphur, yielding a globule of silver. It is a valuable but rather rare silver ore; it occurs in the ores of the Comstock Lode, in Nevada, and has been as yet found in but few localities in California, as follows: Minietta Belle mine, Inyo County; in veins, eight miles south of Benton, Mono County (Aaron); in the Kearsarge Mountains, near Independence, Inyo County, in cubical crystals (Aaron). It occurs in irregular amorphous masses, Oriental mine, Deep Spring Valley, at a depth of sixty feet from the surface No. (—). In testing this mineral with the blowpipe, it was found that on strongly heating a small fragment without flux, it formed a globule without immediately decomposing, but on allowing the globule to cool slowly by gradually diminishing the flame, and at length discontinuing it altogether, the dark colored globule became coated with dendritic crystals of metallic silver, which was a beautiful object when viewed under the microscope with a low power.

11. ARSENIC. Etym. *Arsenicum* (Latin). See also Arsenolite.

Arsenic, in a metallic or native state or condition, is found in Monterey County, at the Alisal mines, twenty-five miles from the Mission of San Carlos. (Blake.)

ARSENICAL PYRITES—see Arsenopyrite.

12. ARSENOLITE. Etym. "*Arsenicum*" (Latin).

Is an oxide of arsenic, having the following composition:

Arsenic	75.76
Oxygen	24.24
	100.00

It is identical with the white arsenic of commerce. The known localities are few. Blake gives as a locality the Amargosa mines in San Bernardino County, where it occurs in large masses.

Arsenolite is generally in stalactitic crusts, and it is doubtful if it has before been found in distinct crystals; when pure it has a specific gravity of 3.729. Cleveland, in his treatise on mineralogy and geology, published in 1816, makes the following significant remark: "When we consider the solubility of this oxide in water, and its effects on the stomachs of animals, we must recognize the goodness of the Creator in rendering it a rare mineral."

Crystals of arsenolite from the Exchequer mine, Alpine County, were shown at the Paris Exposition of 1878, changed from enargite. The manner of their formation is curious. Large quantities of the ore containing enargite had accumulated on the dump of the mine, which, undergoing chemical change, became hot; the miners describe it as having taken fire; fearing a loss, and not knowing the cause, they threw large quantities of water over the pile; when chemical action had ceased, beautiful crystals of arsenolite were found to have formed in the cavities of some of the largest masses of the ore. Some of the crystals were over half an inch in diameter, in perfect and modified octahedrons, having an adamantine luster, some transparent, while others were translucent or opaque.

13. ARSENOPYRITE. Etym. *Arsenic and Pyrite.*

Arsenopyrite or Mispickel is rather a common mineral in California, and is almost invariably associated with gold; sometimes the gold is contained in the mineral in surprising quantities, from which it can be recovered by roasting and subsequent treatment with acids. A portion of the gold is free and may be separated by simple crushing and vanning in water, or panning, as the operation is called in California. After roasting, if the mass is very slowly heated in a muffle with borax, the gold "sweats out" and appears on the surface in brilliant globules, while mispickel *per se* has no value except perhaps for the arsenic it contains, which could be easily recovered. As an associate and bearer of gold, it is a mineral to which attention should be given, and a few words as to the method of determining it will not be out of place.

Its luster is metallic, sometimes dull on the surfaces when long exposed to the elements; color, grayish white to almost silver white; quite brittle.

H=5.5 to 6, sp. gr. 6.3 to 6.4. It contains:

Arsenic	46.0
Sulphur	19.6
Iron	34.4
	100.0

It sometimes contains a little cobalt, rarely as much as 9 per cent; and sometimes nickel. When heated B. B., dense white fumes arise, which have the odor of onions or garlic. When fumes cease to be given off, the residue is attracted by the magnet. During the operation of roasting the charcoal is coated with white arsenious acid; in a closed tube B. B., a sublimate of sulphide of arsenic, of a deep red color, forms; and above it a black lustrous mirror of metallic arsenic. In an open tube the sublimates are those of sulphurous and arsenious acids; the former invisible but recognized by the smell, and the latter a white coating, which, under the microscope, is seen to be a collection of brilliant octahedral crystals. These experiments should be made with care and on small portions, for the fumes are poisonous.

The known localities of mispickel in California are numerous. The mineral is found in the gold mines in Grass Valley, at the Betsey mine, with gold (Blake); with blende and galena, near Auburn, Placer County; with tellurium and gold, North Fork claim, Forest City, Sierra County, discovered by accident in running a tunnel in a gravel claim, very rich in gold; in San Diego County, also rich in gold; in Inyo County, at several localities; Eureka mine, Calaveras County, with gold (Blake); and elsewhere in many of the gold mines of the State.

(4169) is Mispickel with gold, found near Georgetown, El Dorado County.

ASBESTUS—see Amphibole.

ASPHALTUM—see Petroleum.

14. ATACAMITE. Etym. "*Atacama*," a province in Bolivia.

Atacamite is chloride of copper, and a rare mineral. Dana gives the Inyo district, Inyo County, as a locality. I am very familiar with the country mentioned, and think the statement is a mistake—at all events, I have never seen it or heard of it in the State.

AVENTURINE—see Quartz.

15. AZURITE. Etym. *Azure, a blue color*. Mountain Blue, Blue Malachite, Chessy Copper, Azure Copper Ore, etc.

A hydrous carbonate of copper ($2\,Cu\,O\,CO_2 + Cu\,O\,HO$):

Oxide of copper	69.2
Carbonic acid	25.6
Water	5.2
	100.0

H. 3.5—4, sp. gr.—3.5—3.8. Luster, vitreous; color, azure blue; streak lighter; transparent; sub-transparent. In closed tube gives off water and turns black; dissolves in acids with effervescence. B. B. on ch. is reduced to metallic copper. When wet with hydrochloric acid the blowpipe flame is colored blue.

Azurite is a valuable ore of copper, easily reduced, and in a state suitable for the manufacture of sulphate of copper. When pure it is sometimes used as a pigment, under the name of Mountain Blue. It was known to the ancients under the name of Cæruleum Lapis Armenius. It is common in the Inyo Mountains, from White Mountain to Coso, but not as yet found in any considerable quantity. It occurs with cerusite, anglesite, and bindheimite, in the Modoc mine, Inyo County; also in Monterey County, and at Copperopolis, Calaveras County (Dana).

16. BARITE. Etym. "*Heavy*" (Greek), Barytes, Heavy Spar, Terra Ponderosa, Cawk, and many other names.

The element Barium is named from this mineral. The term *Terra Ponderosa* was applied by the earlier chemists and mineralogists from its unusual weight. It is a sulphate of Baryta, having when pure, the following composition:

Baryta	65.7
Sulphuric acid	34.3
	100.0

H. 2.5—3.5, sp. gr. 4.3—4.72. Luster vitreous, streak white, color from pure porcelain white to dark shades of blue, red, yellow, brown, and gray. Transparent, translucent, opaque; found amorphous and in crystals. It is insoluble in acids, but may be decomposed and rendered soluble by fusion with carbonate of soda, or caustic potash. The mineral is slightly soluble in water, 200,000 parts of water being required to dissolve one part of Barite. When heated B. B. on ch. it generally decrepitates and fuses into a globule. On continuing the heat it sinks into the coal; a portion of this being removed and placed on a clean silver coin and wet with water produces a black spot (sulphide of silver). Baryta is used in the arts as an adulterant for white lead and other paints; to give weight and body to paper; in the refining of beet sugar; in the manufacture of plate glass (carbonate); in pyrotechnics (nitrate); as a chemical reagent (chloride and carbonate); in medicine, and as a pigment under the name of permanent white, used as a water color; and in the manufacture of paper hangings. The element Barium was discovered in 1808 by Sir Humphrey Davy. In 1872 in England 4,650 tons of Sulphate of Baryta, and 4,442 tons of the carbonate were raised from the mines, having a value of £7,-078. Barite is largely mined and prepared for market in Connecticut, in the vicinity of Stamford.

It occurs in small quantities at a number of localities in this State: With silver ores in the Calico mines, San Bernardino County (4167, 4234, 4735, 4953, 5027), milk white and honey yellow; with lead and copper ores, north arm of Indian Valley, Plumas County (Edman); with tetrahedrite, Irby Holt mine, Indian Valley, Plumas County; in the White Mountains, Inyo County; in a vein in the Alabama Range, Inyo County (Aaron); with gold, Malakoff hydraulic mine, North Bloomfield, Nevada County (4085); in the Morning Star mine, Alpine County, in the Satellite copper mine, Calaveras County, and elsewhere.

17. BERNARDINITE. Etym. *San Bernardino County, California.*

Is a resin found in the southern part of the State. The specimen in the State Museum (1460) was found near Santa Monica, Los Angeles County. The sample analyzed and described by J. M. Stillman, in the American Journal of Science and Arts, third series, volume 18, folio 57, was from San Bernardino County. Mr. Stillman, in a subsequent paper, in the same journal, third series, volume 20, folio 93, expresses the opinion that it is of recent vegetable origin. It is to be hoped that further information will be gathered concerning this substance.

18. BINDHEIMITE. Etym. "*Bindheim*," the chemist who first analyzed it.

Is a hydrous antimoniate of lead, or a compound of the oxides of the two metals; the antimony oxide acting as an acid, the lead as a base.

Oxide of antimony $Sb. O_5$	31.71
Oxide of lead Pb. O.	61.38
Water	6.46
	99.55

It is a rare mineral, resulting from the decomposition of other antimonial ores. The following California localities have been noted. The mineral has not been verified by analysis and there is some doubt as to its being really Bindheimite. Found in the Union mine, Cerro Gordo, Inyo County, and with Anglesite in the Modoc mine, Inyo County (1648).

19. BIOLITE. Etym. *Biot*, French physicist who first studied its crystallography. Hexagonal Mica. See also Mica.

It occurs near Grass Valley, Nevada County. Specimen in cabinet of C. W. Smith, Grass Valley (Blake).

BISMUTH—see Bismutite.

20. BISMUTITE. Etym. *Metal Bismuth.* Hydrous Carbonate of Bismuth, Stream Bismuth.

When pure it consists of:

Bismuth	90.00
Carbonic acid	6.56
Water	3.44
	100.00

H=4.—4.5, sp. gr.=6.8—6.9, dull, brittle, opaque, color yellowish to nearly white. This mineral is represented in the State Museum by a single specimen found in drift, while sluicing for gold, on Big Pine Creek, Inyo County (4641). A specimen exactly similar has been sent to the Museum from Phœnix, Arizona, found with gold in dry washing.

The metal Bismuth is white, hard, brittle, and easily fusible. H=2.25, sq. gr.=9.727 to 9.861, fuses at 283° F. It was first recognized as a distinct metal by Agricola in 1520, before which it was confounded with lead. It occurs mostly in a native state, but also combined with sulphur, carbonic acid, or oxygen, and mixes with other metals and minerals. On a large scale native Bismuth is separated from its gangue by gentle heat.

Neutral solutions of Bismuth have the remarkable property of being wholly precipitated by dilution with water; advantage is taken of this in the purification of the metal. Bismuth may be recognized by heating it B. B. on ch., when a characteristic yellow incrustation forms; the presence of lead, antimony, and other elements interfere with this reaction. The following is from the Manual of Determinative Mineralogy, by George J. Brush:

In the presence of lead and antimony Bismuth can be detected in the following manner: The mixture of the three oxides is added to an equal volume of sulphur and treated in a cavity upon charcoal with R. F.; the oxides are thus converted into sulphides. The assay is then placed upon a flat coal and treated with the R. F. and the O. F. until antimonial fumes have nearly ceased; the residue is placed in a mortar and pulverized and mixed with an equal volume of a mixture of one part of iodide of potassium and five of sulphur; it is then heated in an open glass tube and if Bismuth is present a distinct *red sublimate* of Iodide of Bismuth will be deposited a short distance above the yellow sublimate of lead; the sublimate of iodine, which is liable to be deposited higher up the tube, must not be confounded with the Bismuth sublimate.

This or the following test may be made: The pulverized substance is digested in hot nitric acid for some time, the liquid decanted and evaporated nearly to dryness, and poured drop by drop into a glass vessel of water; a white cloudy precipitate shows the presence of Bismuth.

Bismuth is used in the arts, in certain alloys, in medicine, as a cosmetic or face powder by women, as a pigment, etc.

TABLE OF USEFUL ALLOYS CONTAINING BISMUTH.

Name of Alloy.	Bismuth.	Copper.	Tin.	Antimony.	Lead.	Mercury.	Total.
1. Pewter	1.72	6.77	84.74	6.77	--------	--------	100
2. White metal for table bells	0.63	2.06	97.31	--------	--------	--------	100
3. Britannia metal	1.78	1.78	89.30	7.14	--------	--------	100
4. Amalgam for spherical mirrors	80.00	--------	--------	--------	--------	20.00	100
5. Queen's metal	8.34	--------	75.00	8.33	8.33	--------	100
6. Type metal and calico-printing blocks	16.66	--------	50.00	--------	33.34	--------	100
7. Fusible alloy, Newton's	50.00	--------	20.03	--------	29.97	--------	100
8. Fusible alloy, Rose's	50.00	--------	25.00	--------	25.00	--------	100

Alloys Nos. 7 and 8 fuse in boiling water. Spoons made of them melt while stirring a cup of hot tea. They serve a useful purpose in the mechanic arts. Fusible plugs made of an alloy containing bismuth are employed to prevent explosions in steam boilers; when the water is low the heat rises above the melting point of the alloy, which fusing, opens an orifice through which the steam escapes harmlessly. Bismuth is a high-priced metal, owing to its scarcity and the limited demand for it.

Bitumen—see Asphalt, under head of Petroleum.

Bituminous Shale—see Petroleum.

Black Jack—see Sphalerite.

Black Sands—see Magnetite.

Blende—see Sphalerite.

Bloodstone—see Quartz.

Blue Malachite—see Azurite.

Boracic Acid—see Sassolite.

21. BORATE OF STRONTIA.

Mentioned in letter written by Dr. John A. Veatch to the California Borax Company, quoted in full in the Third Annual Report, Part 2, Fol. 15.

22. BORAX. Etym. *Boorak*, or *Baurach* (Arabic), Bi-Borate of Soda, Tincal, Native Borax, etc.

Borax, crystallized, prismatic, equivalent to native borax. NaO $2BO_3+10HO$=atomic weight, 191.

Boracic acid	36.65 per cent
Soda	16.23 per cent
Water	47.12 per cent
	100.00

Borax crystallized, octahedral. $NaO\ 2BO_3+5HO$=atomic weight, 146.

Boracic acid	47.94 per cent
Soda	21.23 per cent
Water	30.83 per cent
	100.00

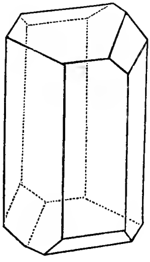
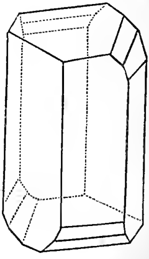
Borax, anhydrous. $NaO\ 2BO_3$=atomic weight, 101.

Soda	30.70 per cent
Boracic acid	69.30 per cent
	100.00

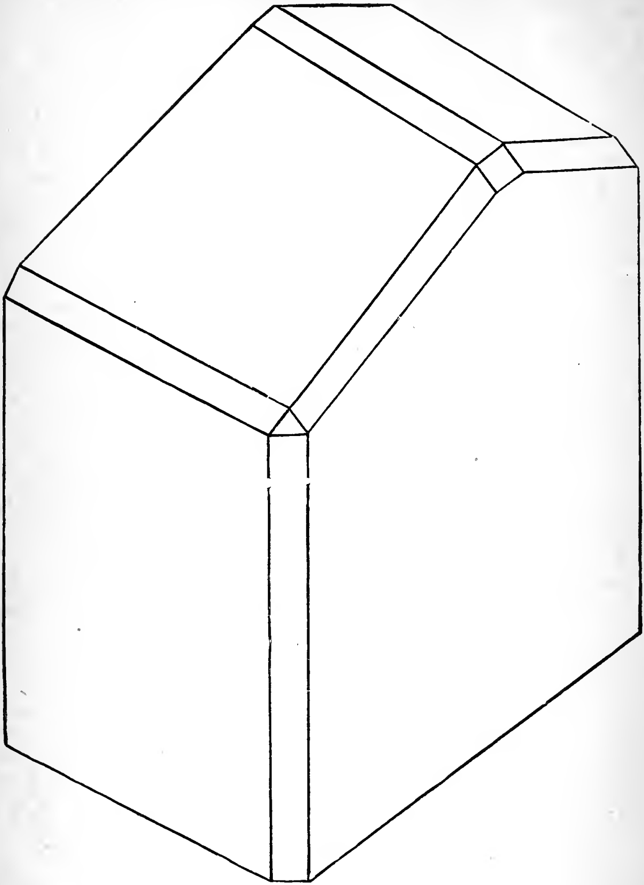
H=2.—2.5, sq. gr.=1.716. Borax has a sweetish taste and an alkaline reaction. It dissolves in twelve parts of cold water and in two parts of boiling water. At a low heat it melts in its water of its crystallization; if the heat be continued, it swells and becomes a white porous mass. At a red heat it fuses into a transparent fluid, which becomes, when cold, a transparent solid, resembling glass. Fused with fluorspar and bisulphate of potash, it colors the blowpipe flame distinctly green. Luster, vitreous; color, white, gray, brown, pinkish, greenish; generally translucent, sometimes transparent; brittle, streak white; phosphorescent if powdered in the dark.

The most beautiful transparent and perfect crystals form at the borax works in weak solutions, which have been allowed to stand for a considerable time undisturbed. The purest natural crystals are found on the property of the San Bernardino Borax Company, which are shoveled into the dissolving tanks by the ton. They differ from the celebrated crystals from Borax Lake, Lake County, in being transparent and inclosing fluid in large cavities.

The following figures of prismatic borax crystals are from *Hauy's Traité de Mineralogie:*

Crystal of Native Borax from Borax Lake. Natural size.



The early history of borax is vague and uncertain. The statement by some writers that the substance was known to the ancients, lacks confirmation. There is but little reason to believe that *chrysocolla*, literally, *gold glue*, was borax. Pliny's description shows it to have been of an entirely different nature. The name *chrysocolla* was given to borax by Agricola (*de re metallica*) because it was used in soldering gold. Agricola was a celebrated metallurgist who lived in the first part of the sixteenth century. One author (Parke's Chemical Essays, London, 1830,) quotes from the writings (*Vita Caligulæ*) of Suetonius, who lived in the first century, that "the circus in his time was covered with vermilion and borax." The first borax known in Europe came from the East.

In 1732, Stephen Francis Geoffroy, a celebrated chemist, made the first analysis of borax, and was the first to notice the green flame imparted to burning alcohol by free boracic acid.

In 1748, Baron announced the discovery that borax was sedative salt and soda.

In 1772, the first authentic accounts were received in Europe as to the borax lakes of Thibet. According to Turner, "these lakes lie a few days' journey from Tezhoo Lomboo. The borax is found in masses in the mud at the bottom, beneath the stagnant water, with salt and alkali. Blanc and Pater Rovato say that these lakes lie among the mountains. The most noted (called *Necbal*) is located in the Canton of Sumbul. The water is conveyed in sluices, in which salt crystallizes. The liquor containing the borax is conducted to evaporating basins, in which the borax crystallizes out. It is impure, and has the form of six-sided crystals, sometimes colorless, at others, yellowish or green; always covered with an earthy incrustation, fatty to the touch, and with a soapy smell." Another account informs us that "the borax is dug from the margin of the lake. The crystals removed are replaced by others after the lapse of a certain time."

Simple tests serve to detect the usual foreign substances contained in borax, natural or artificial. When pure it should dissolve in twelve to twenty-four parts of cold water to a clear solution without color or residue. A sample heated to fusion should leave a residue weighing fifty-three per cent, nearly. If adulterated with nitrate of potash it will deflagrate when thrown on burning coals. If alum is present as an impurity, its solution will react acid to litmus paper. Artificial borax is often degraded by admixture of phosphate of soda, sometimes to the extent of twenty per cent, in which case its solution will give a yellow precipitate upon addition of molybdate of ammonia mixed with excess of nitric acid. Lime is indicated by a white precipitate, which falls when carbonate of soda is added to the solution. This precipitate dissolves in dilute hydrochloric acid with effervescence. Sulphate of soda and chloride of sodium (common salt), the natural impurities, are indicated, the former by a precipitate with chloride of barium in the presence of free acid, and the latter by the formation of a white curdy precipitate with nitrate of silver in the presence of free nitric acid. The latter precipitate is soluble in ammonia, and is reproduced on the addition of an acid.

If to a solution of boracic acid, or an alkaline borate, hydrochloric acid is added to slight acid reaction, and a slip of turmeric paper half dipped into it and dried on a watch-glass at 212° Fahrenheit, the dipped portion shows a peculiar red tint; this reaction, which is delicate, must not be confounded with similar colors obtained from other substances; to avoid which, experiments should be made with pure solutions, carefully prepared, to educate the eye.

Borax may be determined volumetrically. For this assay a solution of sulphuric acid must be prepared, in which an exact chemical equivalent of the acid shall be contained in each litre. This acid solution, called "normal sulphuric acid," must be carefully preserved in a well stoppered bottle, as on its purity and uniform strength depend the accuracy of the results. An equivalent of the borax to be assayed (or rather what would be an equivalent if it were pure) must then be dissolved in distilled water.

Now if both solutions contain exact equivalents, they would neutralize each other if poured together. In a like manner, if a tenth of each solution were mixed they would neutralize each other. The tenth of a litre is a convenient measure for the assay, because it contains 100 cubic centimeters (C.C). If 100 C.C. of the acid solution neutralized the tenth of an equivalent of borax in solution, it would be evident that the sample was pure. If 80 C.C. only were required, the sample contains eighty per cent of borax. In other words, each C.C. of the acid solution represents one per cent of crystallized borax in the sample.

When litmus is added to a solution of borax, only a purple red color is seen while any borax remains undecomposed; but, upon adding sulphuric acid, at the instant that the last atom of soda is changed to sulphate, a light red color appears.

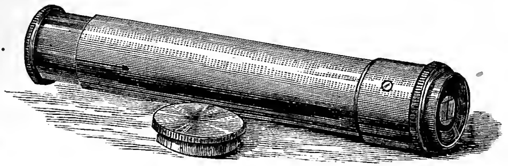
Upon these reactions, the volumetric assay is based.

It has been shown elsewhere, that the chemical equivalent of crystallized prismatic borax is 191. One tenth of this weight—19.1 grammes of the borax—is dissolved by shaking in cold water: 250 to 300 cubic centimeters will be required. The solution must not be filtered.

This solution is placed in a clean beaker, solution of litmus added until a deep color is imparted to the fluid. Normal sulphuric acid is then dropped in from a burette, graduated to cubic centimeters and tenths, until the color suddenly changes to a bright red. The first test may be made somewhat carelessly, as it will only be an approximation. The beaker is then washed out, and the operation repeated; this time with greater care. The result will be nearly correct. A third experiment will serve to verify the result. The reader should refer to some practical work on chemistry for description of the apparatus and method of making the test solutions. *Sutton's Systematic Handbook of Volumetric Analysis*, third edition, is one of the best.

Only borax can be estimated by this method. The determination of boracic acid in minerals and other substances, is extremely difficult, and can hardly be explained without an elaborate description, which may be found in text-books on analytical chemistry. In the volumetric method described above it is customary to deduct 0.5 C.C., to correct for the excess of sulphuric acid required to develop the red color in the assay.

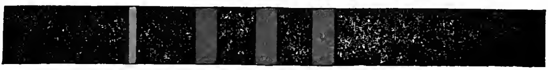
Boracic acid is soluble in 27 times its weight of water at 60°, and in 2.96 parts of water at 212°. The hydrated acid dissolves in alcohol, which burns with a characteristic green flame, seen even in the presence of soda salts, which impart a yellow color to the flame. But, if soda is largely in excess, the green color is masked, and can only be observed when the alcohol is nearly consumed, and the distinguishing color is more marked if the expiring flame is gently agitated by breathing upon it, but, under these circumstances, a good eye is required to distinguish the color. By far the best color test is made by the use of the direct vision spectroscope, which shows three distinct pale green bands in the green part of the spectrum. I have used the beautiful little instrument made by Browning, of London, and which is shown in the figure:



The use of this instrument is simple, and once seen is easily understood and practiced. The substance supposed to contain boracic acid or a borate is placed in an evaporating dish, and a few drops of sulphuric acid added. A brisk effervescence generally takes place. The contents of the dish must be stirred, which may be done with a small stick, or anything convenient at hand. Alcohol is then poured in, in small quantity, and ignited. All that is then required to determine the presence of borax or boracic acid is to look at the flame through the spectroscope. Three distinct and beautifully green bands will be seen, if boracic acid is present.

If *free* boracic acid is contained in the sample, the green bands may be produced without the introduction of sulphuric acid. It is best, however, always to use the acid, which decomposes the salt containing the weaker boracic acid, and to make a secondary test to prove the boracic acid to be free or otherwise.

The experiment should be made in a dark room. The bands are best seen when the slit is so far closed as to show the yellow sodium band, always present, as a very narrow line.



With the spectroscope, a bottle of strong sulphuric acid, one of alcohol, and a small evaporating dish, the prospector, although unskilled in chemical handicraft, may detect with unerring certainty the presence or otherwise of boracic acid, or any of its salts, in the deposits he may find.

When boracic acid is suspected in steam issuing from hot springs, it is only necessary to condense a portion of the steam. The resulting water is evaporated nearly to dryness at a *very gentle* heat. Alcohol is then added, and the flame examined as before. This test shows the presence of boracic acid in the waters of Mono Lake, and in the eruptive mud from the mud volcanoes of the Colorado Desert, San Diego County.

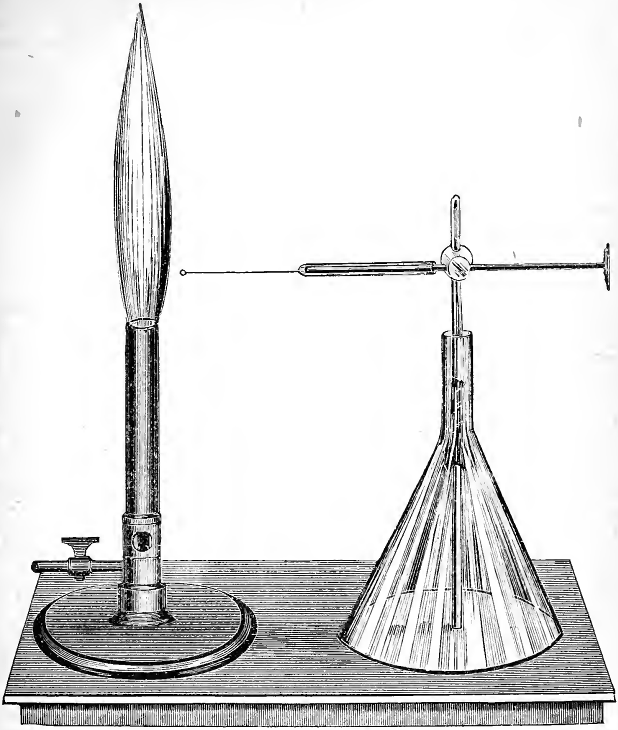
The only weak point in this determination lies in its extreme delicacy. In inexperienced hands it might lead to the hope that the sample was rich when boracic acid was present only in small quantities; but a little experience will correct this, for it will be seen that when the quantity is small the bands are faint, and come and go in an intermittent manner; while, if the quantity is large, they are distinct and well defined, and the color a clear green. As with the sodium band, the intensity of the color is an index to quantity—all of which may be learned by experience. In making this determination all bands of other substances present, as lithium, potassium, etc., must be disregarded.

In prospecting the deserts, there are no facilities for chemical operations, and the prospector, generally poor, can but ill afford to send his samples to San Francisco, or pay the cost of chemical analysis. These considerations have, no doubt, retarded the development of the borax interests of the State.

It is sometimes inconvenient to use alcohol in the manner described. The experiment can be made with equal facility in the flame of a Bunsen gas burner, or spirit lamp.

The substance to be examined is supported in a loop of platinum wire. The wire may be held in the hand when the color is to be observed by the unassisted eye; but when the spectroscope is used it must be supported. A convenient support may be improvised in the following manner: A small glass funnel is placed on the table, with the tube part upwards. A glass rod or wire, small enough to pass easily into the tube, is cut to a convenient length, wrapped with paper, and pushed into the tube of the funnel. The paper acts as packing, and when arranged the rod may be raised or depressed by pushing up or down in the tube. A common cork, of medium size, is pierced with a cork borer diametrically, and placed on the rod. A wire is thrust through the cork at right angles with the vertical rod. This wire may be three or four inches in length.

A small glass tube may then be selected, and cut to the length of an inch and a half. One end is closed in the blowpipe flame, and a short piece of platinum wire inserted while the glass is still hot; when cold the wire will be firmly set in the closed end of the tube; the other is open. In the end of the platinum wire a small loop is made; when all is ready the substance is ground in an agate mortar with a small excess of a mixture of equal parts of bisulphate of potash and fluorspar. The platinum wire is first held in the flame for a moment to see that it is clean and gives no color. The flame is examined to be sure that no color is imparted by any uncleanness of the burner. If the flame is blue, and perfectly non-luminous, it may be observed through the spectroscope, and if no color is seen except the bright yellow sodium band the apparatus is ready for use. To make the experiment, the Bunsen burner is lighted, and a full head of gas turned on, making the flame five or six inches long. The glass tube with its platinum wire and loop is slipped off from the horizontal wire, and the loop dipped into a small vessel of distilled water, and then into the mixture in the agate mortar. The tube is then replaced on the wire, and the whole stand pushed near the flame with the loop and the assay about half an inch above the top of the burner. The spectroscope is then held to the eye in the left hand, while the stand is gently pushed with the right until the substance to be examined touches the flame. The green bands will instantly appear if boracic acid is present. This description will be fully understood by a glance at the following engraving:



Apparatus for observing the green color of burning boracic acid, scale ½.

Bisulphate of potash is prepared by placing a convenient quantity of powdered sulphate of potash in a porcelain capsule and wetting it with concentrated sulphuric acid. The mixture must be heated until no more white fumes are given off, and a small portion taken out on a glass rod cools into a hard coating. The heat employed must be sufficiently great to keep the mixture in a state of fusion until the excess of acid is driven off. When cold, the mass must be pulverized and kept in a glass-stoppered bottle for use.

USES OF BORAX AND BORACIC ACID.

The consumption of boracic acid and its salts is only limited by the supply. It is very largely used in the manufacture of pottery and earthenware as a glaze. In 1820, Mr. Wood, of Liverpool, applied boracic acid to the glazing of pottery, which has continued, with increasing consumption, to the present time.

The following mixtures are published. For common English porcelain:

Feldspar	45 parts
Silica	9 parts
Borax	21 parts
Flint glass	20 parts
Nickel	4 parts
Minium	12 parts
	111 parts

For figures and ornaments:

Feldspar	45 parts
Silica	12 parts
Borax	15 parts
Flint glass	20 parts
Nickel	4 parts
Minium	12 parts
	108 parts

The glaze is made by melting the ingredients together, and afterwards grinding them with water, into which the ware is dipped and dried. The articles are first partially burned, in which form they are called "biscuit."

Large quantities of borax are consumed in the potteries at Trenton, New Jersey; East Liverpool, Ohio; Philadelphia, and Cincinnati, and will eventually be used in prospective potteries in our own State.

Borax has lately been extensively applied to the manufacture of porcelain-coated ironware, known as "graniteware."

Boracic acid is used in the manufacture of certain varieties of glass and in "*strass*," which is the base of artificial gems named after the inventor, Strass of Strasburg, who lived in the seventeenth century, and who was the first to make artificial gems of this character.

The following is the composition of strass:

Pure silex	300 parts
Potash	96 parts
Borax	27 parts
White lead	514 parts
Arsenic	1 part
	938 parts

All the ingredients must be pure, especially the borax, which must be prepared from pure boracic acid. Tincal is not suitable.

The mixture is put into a Hessian crucible, and kept at the highest heat of a pottery furnace for twenty-four hours. The longer it is kept in a state of fusion the clearer and more homogeneous it will be when cooled. It is used by lapidaries for imitating diamond, topaz, and other white gems. For colored gems various metallic oxides are added in proportions only learned by experience. The coloring matter must be in the finest powder, and not only very intimately mixed, but the mixture must be very strongly heated, the heat must be long continued, and the cooling gradual.

It is stated in Parke's Chemical Essays that four ounces of borax and one ounce of pure fine white sand will make a pure glass, so hard as to cut common glass like the diamond.

The following formula is given of the brilliant greenish yellow glass of Sevres:

Silica	19.32
Protoxide of lead	57.64
Soda	3.08
Boracic acid	7.00
Protoxide of iron	6.12
Oxide of zinc	2.99
Antimonic acid	3.41
Potash	.44
	100.00

Vitrifiable pigments for glass staining and encaustic tiles are rendered fusible by admixture of borax. The following formulæ are given:

1. One part sand, three parts litharge, one third part borax. The borax must be fused in a platinum crucible and poured into water, and, when cold, ground fine.

2. One part sand, two and three quarters parts litharge, three eighths parts borax.

3. One part sand, two parts litharge, one fourth part borax.

4. One part sand, three parts minium, one eighth part borax.

5. Six parts white sand, washed, and heated to redness, four parts yellow oxide of lead, one part borax glass, one part saltpeter.

6. One part sand, two parts litharge, three quarters parts borax glass.

7. Eight parts white quartz sand, washed and calcined, four parts borax glass, one part saltpeter, one part white chalk.

All prepared as in No. 1.

In the art of enameling, borax is also largely used as a flux.

Borax has the property of dissolving the metallic oxides, which makes it useful in soldering metals. It renders the surfaces to be joined, clean, so that the solder "runs" and fills the joint between them. For this purpose, as well as in welding iron, the octahedral is the most desired, as, containing less water, it sooner settles down quietly on the work. In soldering small articles, the borax is rubbed on a slab of slate, with water, and the mixture put on with a camel's hair brush.

The same property is taken advantage of in blowpipe chemistry, to determine the presence of certain metals which may be in the substance under examination. A loop is prepared on the end of a thin platinum wire, in which borax is melted in the blowpipe flame; a small quantity of the substance in a fine powder is then introduced by wetting the borax bead and touching it to the powder. The bead is again subjected to the flame; first in the outer, and then in the inner flame, and allowed to cool while being closely observed.

BLOWPIPE REACTIONS.

	Outer Flame.		Inner Flame.	
	Hot.	Cold.	Hot.	Cold.
Yellow	Vanadic acid. Sesqui-oxide of iron. Oxide of lead. Ter-oxide of bismuth and of antimony.		Tungstic, titantic, vanadic, and molybdic acids.	
Red	Oxide of chromium. Sesqui-oxide of cerium.	Oxide of nickel.		Oxide of copper.
Violet	Sesqui-oxide of manganese. Oxide of cobalt containing manganese.			
Blue	Oxide of cobalt.	Oxide of cobalt. Oxide of copper.	Oxide of cobalt.	Oxide of cobalt.
Green	Oxide of copper.	Sesqui-oxide of chromium.	Sesqui-oxides of iron, chromium, and uranium.	Vanadic acid. Sesqui-oxides of iron, chromium, and uranium.

Borax has great detersive properties and is very useful in the laundry. The washerwomen of Holland and Belgium, so celebrated for their fine and white linen, have used borax as a washing powder for many years. They add borax in the proportion of half a pound to ten gallons of boiling water. For washing laces, cambrics, and even woolen blankets and other goods, it will be found very useful. It is also a valuable cosmetic, rendering the skin soft, and it is claimed it will prove a preventive and even a cure for certain skin diseases. It is an excellent shampoo, without any admixture except water, and is perfectly harmless. For cleaning brush and comb it will be found very useful. It is so essential to the toilet that a bottle of it should be kept always ready, prepared as follows:

A quantity of refined borax is shaken up in a bottle with water until no more will dissolve. The solution is then poured off into a clean bottle and half the quantity of water added, and both mixed by shaking. If not clear it must be left some time to stand and the clear portion poured off, or, better still, filtered through paper. In this condition it may be added to a basin of water, used as a mouth wash, and other ways as described.

In medicine, according to the United States Dispensatory, borax is a mild refrigerant and diuretic. It is a remedy for nephritic and calculus complaints dependent on an excess of uric acid. Externally it is used in solution as a wash in scaly eruptions, and for other diseases.

Borax and boracic acid are used to render cream of tartar more soluble. The formula given in the French codex is as follows:

Four hundred parts cream of tartar, and 100 parts of boracic acid are dissolved in a silver basin with 2400 parts of water at a boiling heat. The solution is kept boiling until nearly all the water is evaporated. The heat is then moderated and the mixture stirred. When it has become very thick it is removed in portions, which are flattened in the hand, well pounded, and powdered. This is soluble cream of tartar.

A solution of borax is used as a gargle for sore throat and in colds, and it has been found effective in cases of epizooty in horses. In 1873 experiments were made in San Francisco which gave favorable results. The doses were four ounces daily, given pulverized in the food.

In 1878 Smith Bros. sold 20,000 pounds of borax to Chicago consumers, to be used in preserving and canning beef.

Borax is used as a mordant in calico printing and in dyeing, and as a substitute for soap in dissolving gum out of silk; in solution as a wood preservative, and in the manufacture of soap. A varnish made by boiling one part of borax with five parts of shellac is used in stiffening hats. With caseine borax forms a substance which is used as a substitute for gum. A solution of borax in water may be mixed with linseed oil and used for cheap painting.

Borax is extensively used in assaying, in the metallurgy of ores, and in the smelting of copper, and it is said to be an excellent insecticide, being especially obnoxious to cockroaches.

There are probably other uses to which it has been put, and no doubt new applications will be found for it if the production should increase.

Borax was first discovered in California in the waters of Tuscan Springs, in Tehama County, January 8, 1856. The water was brought to San Francisco by Dr. Trask, State Geologist, and the analysis made by L. Lanszweert. The crystals then obtained were sent to the Museum of the California Academy of Science. Borax Lake was discovered by Dr. John A. Veatch, in September, 1856. This deposit was worked from 1864 to 1868, during which time it produced 1,181,365 pounds of borax. Borax fields were discovered in San Bernardino County, February 14, 1873. These deposits have been worked by the San Bernardino Borax Mining Company, who have produced very large quantities of borax. This valuable mineral has since been found at a number of localities in the State: In Death Valley, Inyo County, in 1873; and Borate of Lime (ulexite) was discovered at Desert Springs, called also Cane Springs, in Kern County, February 15, 1873, from whence a considerable quantity has been extracted. The dry lake in which the borates are found is situated in Township 30 south, Range 38 east, Mt. Diablo base and meridian. Borax and Borates have been found in considerable quantities in San Bernardino County, near Calico, which deposit is at the present time being worked.

PRODUCTION OF BORAX IN CALIFORNIA.

In the third annual report of this office, folios 78, 79, the total production of borax in California and Nevada was given, and for California as follows: From discovery in January, 1856, to June 1, 1883, 17,857,986 pounds. The yield of California from June 1, 1883, to January 1, 1884, is estimated by Mr. S. Riddell at 1,866 tons, of 2,000 pounds each, or 3,732,000 pounds.

The receipts at San Francisco, Mohave, and Sacramento, from January 1 to April 30, 1884, inclusive, were 1,522,300 pounds, all of which was produced by California.

Received at San Francisco	1,289,500 pounds
Received at Mohave	190,000 pounds
Received at Sacramento	42,800 pounds
	1,522,300 pounds

To June 1, 1883	17,857,986 pounds
To January 1, 1884	3,732,000 pounds
To April 30, 1884	1,522,300 pounds
Total yield	23,112,286 pounds

It is necessary now to speak only of the progress made since the publication of the last report by this industry, its present condition, and the outlook for it on this coast in the future. Although the discovery of this salt, made during the past year in the eastern part of the Calico district, San Bernardino County, led to a good deal of prospecting for other deposits in that part of the State, the movement subsided before the Summer was over, without noteworthy results; though, as usual, numerous additional finds were reported, none of which have, however, since met with confirmation; nor is this matter for serious regret, the want of the home producer resting just now, not so much in the discovery of new deposits of the crude material, as in improved prices for the manufactured product.

The several companies previously in the field have, during the twelve months under review, continued work, no others having since been formed, or at least commenced active operations. Our exports to foreign countries consisted of 1,238,407 pounds to Liverpool; 20,231 pounds to China; 8,882 pounds to Japan; and 6,301 pounds to Mexico, with smaller lots each to Australia, British Columbia, and the Hawaiian Islands. At the opening of 1883 refined borax was selling in New York at 13 cents per pound, but soon fell to 10 cents. After the enactment of the new tariff law the price there advanced to 15 cents, but finally dropped to 9, the rate now ruling in that market, this being for carload lots. The price of borax in San Francisco is less the price in New York by cost of transportation—say 1¼ cents per pound. The present low price of this commodity is due to heavy deposits of the crude article having been discovered, not only in California and Nevada, but in other parts of the world; the latest find of this kind reported being on the eastern side of the Andes in the States of La Plata, where the borate of lime is said to occur in large quantities and of excellent grade. Some considerable lots of this material, shipped via Rosario to Liverpool and Hamburg, met with ready sale on account of its richness. While the Tincal trade of India has been active and the manufacture in Italy of boracic acid has undergone some increment, exportations of the crude material from the west coast of South America have been quite free of late. Add the large production made in California and Nevada, and the causes for so great decline in the prices of borax become amply apparent. Whether the market is to undergo early improvement will probably depend on new and large uses being found for this salt, or on manufacturers being able to effect some arrangement looking to a restricted production.

The wisdom of protecting this industry against a crushing foreign competition, becomes manifest, on comparing the prices our people now pay for borax with those that obtained twenty years ago, before any home production of this salt was made. Accepting the Druggists' Circular as authority, the New York price of borax in the year 1864 was thirty-five cents per pound; a figure we would probably still have to pay for it but for these competing sources of supply opened up in California and Nevada, which to date have furnished the markets of the world forty-five million pounds of commercial borax. Besides retaining in the country large sums of money that would otherwise have been spent abroad in the purchase of this article, this business has been a great help to many other industries; populating districts that but for its presence would have long remained uninhabited. This class of our salines occupy desert regions, far inland, and, for the most part, remote from shipping points, either by sea or rail. They have, therefore, to be worked under many disadvantages; labor as well as supplies being dear in these isolated and wilderness lands.

The following abbreviated statement of the expenditures made by one of our large borax companies for labor and supplies, illustrates how heavily they are taxed on account of these items:

Class of Employés.	Per day.
Blacksmith (first)	$5 00
Blacksmith (helper)	3 00
Engineers	4 00
Teamsters	3 25
Coopers	3 25
Boilermen	2 31
Watchmen	2 31
Laborers	1 25

The wages of clerks, agents, foreman, etc., ranging from $100 to $125 per month; cooks, $50 per month. These are the wages paid white men, who are all boarded and lodged at the company's expense. Chinamen, a few of whom are employed by some of the companies, receive $1 25 per day, boarding themselves. The money paid out for wages by these borax companies ranges from $1,500 to $3,300 per month. For forage, the sums paid out monthly vary from $300 to $600; the cost of other supplies being proportionately high.

As the companies now making borax on this coast are realizing but little if any profits, we need look for no immediate increase of production here, but rather a falling off, unless some of the contingencies hinted at should arise, or other favoring conditions supervene.

23. BORNITE. Etym. *Born*, a chemist of the last century. Purple Copper Ore, Variegated Copper, Horseflesh Ore, Erubescite, etc.

Is a double sulphide of copper and iron. The elements vary in different specimens. The following is the analysis of an average sample:

Copper	58.20
Iron	14.85
Sulphur	26.98
	100.03

Luster, metallic; color, red to purple, rather bronze color. H. 3, sp. gr. 4.4.—5.5. B. B. on ch. fuses to a magnetic globule, with soda gives a globule of copper which is malleable. Bornite is quite common with other ores of copper, especially Chalcopyrite. It is found in California at Light's Cañon, Plumas County, and in the Siegel Lode, Plumas County (Blake); Kings River, Fresno County; with Chalcopyrite and pyrite at Copper City, Shasta County (804); near Lexington, Santa Clara County; Genesee Valley, Plumas County (Edman); at Copperopolis and Campo Seco, Calaveras County; and at numerous localities in the Inyo Mountains, Inyo County.

Bronzite—see Enstatite.

24. BUILDING STONES.

When in the course of events a city springs up in a new locality, stimulated by circumstances into a rapid growth, it is found necessary to utilize convenient materials, generally wood, in the construction of buildings for temporary but immediate use. We are led to believe that wood was extensively used in building ancient cities, which were afterwards rebuilt, first of brick, and then of marble and similar stones. We find it stated by Strabo (book 5, chapter 11, 5), that in his day the "wood of Tyrrhenia was mostly employed for building houses in Rome and in the country villas of the Romans, which resemble in their gorgeousness Persian palaces." A similar experience was made in Chicago, and notably in San Francisco. Wooden buildings have here served their purpose, and are now falling rapidly into a condition of decay. Nearly the whole city must, within a comparatively few years, be rebuilt. The short-lived wooden buildings must and will be replaced by those of a better and more durable character. Even should it be desired to replace them in kind, the forests do not exist to supply the lumber. Great injury has already been done to the State by the depletion of the forests. This cannot continue. While there is and will be lumber sufficient for economical use for many years, still the time has come when other materials must be sought to supplant lumber. Sufficient investigation has been made to show that building stones of excellent quality are abundant in California. The great mass of the earth's crust is composed of seven principal minerals, estimated at nineteen twentieths, as follows:

1. Quartz.
2. Talc or Steatite.
3. Serpentine.
4. Hornblende and Augite (varieties of Pyroxene).
5. Feldspar.
6. Mica.
7. Carbonate of Lime.

When two or more minerals are mechanically mixed they form rocks. Some minerals occur in such large masses that they are classed as rocks, as for example limestones, quartz, ice, etc. The crystalline rocks, granite, and gneiss are complex and contain nearly all the elements which enter into the composition of the plutonic, volcanic, and sedimentary rocks. They disintegrate to sand, kaolin, and alkalies, which form new combinations in soils and minerals. Sandstones, slates, mica-schists, and argillaceous rocks are built up of the ruins of the older crystalline rocks. The study of the rocks is deeply interesting, but lithology must be considered as yet in its infancy. The State Museum contains many specimens of rocks from California and other Pacific States and Europe, with a considerable number of thin sections prepared for microscopic observation. These collections include many valuable building stones. There is a full set of the rocks cut through by the Sutro Tunnel in Nevada, which constitutes a complete section of that great work.

In a State like California, in which numerous chains of mountains cover a large area, building stones abound. It is only necessary to study them and select those most suitable and accessible, and turn them to account. The requirements of building stones vary with the uses to which they are to be put, but the following are the most important desiderata:

First—*Durability*. Resistance to the action of the elements, especially water. Power of resisting the action of fire in the event of a conflagration.

Second—*Beauty*.

Third—*Ease with which they can be cut into suitable shapes*.

Fourth—*Cost of transportation from the quarry*.

It is a great mistake to suppose that the hardest stones are the most durable, or that any stone is indestructible. Climate has much to do with the durability of stone. Obelisks that scarcely showed the attacks of time in the dry climate of Egypt, when removed to Rome, Paris, London, or New York, soon exhibit signs of decay. Edward Clarke, who traveled extensively in Europe, Asia, and Africa, commencing in the year 1800, gives in his published travels much information concerning the durability of building stone. In the Troas he noticed "granite columns lying about, whose surface exhibited a very advanced state of decomposition, * * * serving to confirm a fact of some importance, namely, that the durability of substances employed for purposes of sculpture and architecture is not proportioned to their hardness." He noticed also at Alexandria that the fallen obelisk was considerably decomposed on the exposed surfaces, while on the buried face the hieroglyphics were as perfect as ever. He formed the opinion from his large experience and observation, that Parian marble was the best and most enduring of stones used in ancient sculpture and architecture. Baked bricks and terra cotta were found to be still more durable.

The cathedral at Cologne, partly built in the middle of the thirteenth century, of Bunter sandstone, shows serious indications of decay. The Jurassic limestones of France are soft, easily worked, and very durable. The Tertiary limestones, of which Paris is largely built, are of a similar character. Many buildings in the City of Rome are built of Travertine, a straw-colored tufaceous limestone, deposited by water. The Colosseum, St. Peters, Castle of St. Angelo, the Quirinal, and other noted buildings, are of this stone, which is so soft when first quarried that it can be cut with saws into blocks. At a meeting of the New York Academy of Sciences, January 29, 1883, Dr. Alexis A. Julien read a paper on the decay of building stones of the City of New York. Of 100,193 buildings in New York, 11.6 per cent only are of stone; of this number, 78.6 per cent are of brown sandstone, and 7.9 per cent marble. The soft building stones show considerable decay in five years, those that last twenty or thirty years are considered exceptional. Granites within fifty years begin to decay. Numerous plans have been suggested to stay the progress of the decay, as application of coal tar, paint, oil, soap and alum solution, paraffine, beeswax, rosin, tallow, etc., dissolved in naphtha, turpentine, camphene, and oil; none of these have proved to be more than temporarily effective. His investigations show that all the building stones used in New York show the effect of the climate within a few years, and that some of them fall rapidly into a state of decay. The Ohio sandstone was found to be the most durable of all the stones used, and gneiss the next. French oolite lasts only from twenty to forty years. The climate of San Francisco is such that building stones would last much longer than in New York. It is an important consideration to select for our cities in California the best building stone obtainable, and to profit by the experience made in other countries. San Francisco is destined to become a second Rome. In a few centuries, if it meets with no serious setback, it will be the largest city in the world, at least that is my opinion. We have made serious mistakes in laying out its streets and planning its system of drainage. Let us compensate in a measure by rebuilding it of durable materials, selected with judgment, prudence, and care.

The rocks usually employed in building are:

Granite,
Syenite,
Porphyry,
Freestone, or Sandstone,
Diorite, or Greenstone,
Lavas, including Basalt and Trachyte,
Limestones, including Marble, Tufa, Dolomite, Slate, Serpentine, etc.

All these are found in the State. Some of them are abundant.

The materials for artificial stones, concretes, cements, brick, terra cotta, etc., are also found here; therefore there is no excuse for the construction of cheap and ephemeral buildings in our cities.

Granite is a compound acidic rock, composed of three minerals, Quartz, Feldspar, and Mica, mechanically mixed.

These are described under their different heads—the origin of the name is unknown. The term acidic used above, implies a large percentage of silica, the acid, in contradistinction to "basic," the reverse. Acidic rocks contain above 60 per cent of silica, and range as high as 80 per cent. The word granite applies not only to the well known rock, but to a group of rocks called granitic—as Porphyritic granite, Granulite, Syenitic granite, Graphic granite, Gneissic granite, and a number of other varieties. The constituents, too, vary as to state of aggregation; sometimes one mineral is largely in excess, and in other instances another. The granulation also differs, sometimes so fine-grained that the rock looks almost homogeneous, at others the minerals are in large distinct crystals or masses. Other minerals are also sometimes found in granite, as tourmaline, zircon, chlorite, hornblende, steatite, and others, which impart a somewhat distinctive character to the rock. These admixtures and conditions of texture render it extremely difficult to distinguish one rock from another. Until the microscope was called to the aid of the lithologist, the difficulties seemed insurmountable, as the skill of the chemist failed to distinguish rocks of a similar character; but now a thin section placed in the focus of a suitable microscope reveals distinctive features more decisive to the eye of the practical observer, than the results of a complex chemical analysis. The analysis is not, however, to be despised, for both are necessary in many cases. When hornblende replaces mica, granite becomes Syenite, and when the constituents are laminated or foliated the rock is called Gneiss, pronounced "nice." Graphic granite or Pegmatite contains but little if any mica, and is sought as a constituent in the manufacture of porcelain.

The following is an analysis of a typical specimen of granite, selected from many published:

Silica	73.00
Alumina	13.64
Oxides of iron and manganese	2.44
Lime	1.84
Magnesia	0.11
Potash	4.21
Soda	3.53
Water and loss	1.20
	99.97

The specific gravity of ordinary granite is 2.66. A cubic foot weighs 166.2 pounds. Granite, like many other rocks, absorbs water, some more than others. This is an important matter in considering the value of a building stone. The power to resist crushing also differs with granites from different quarries. The experiment to determine this is made on samples cut to certain uniform sized cubes, from one to six inches, as circumstances require. The harder the stone the smaller is the cube acted upon. Whatever machine or appliance is used, it must be provided with a gauge, to indicate the force applied. Granite has always been a favorite building stone, under the impression that it was as nearly as possible indestructible. This has been proved a fallacy, as mentioned elsewhere. In the mild and dry climate of Egypt granite has resisted the elements well, but, even there, it has suffered material decay, as seen on some of the granite walls of temples. No doubt that rock would endure as long in the dry deserts of southern California and Arizona.

Granite is quite common and abundant in California. The great bulk of the Sierra Nevada is composed of this rock. It is also quite abundant in the Coast Range. Near San Francisco it occurs at Tomales Point, Marin County, Bodega Head and Punta de los Reyes, at Point Carmelo and at Cypress Point, near Monterey, where it has been quarried. At Folsom, in Sacramento County, also extensively quarried. In Amador County, near Volcano; near Grass Valley, Nevada County; in the Temescal range, San Emidio Cañon; Tehachipi, and Tejon.

The first stone building erected in San Francisco was commenced late in 1851, and finished early in 1852. It still stands near the corner of California and Front Streets—204–210 California Street—and is in as good condition now as when first built. The granite was imported from China; the blocks were cut in that country, and laid up by Chinese workmen. There is no evidence of the action of time on the stones, and it may be fairly inferred that granite in San Francisco is a good building stone. The building was erected by Ebbets & Co.

An iron front has been made to replace part of the granite in the lower story. The building was quite an object of interest and pride to the pioneers of California, and was widely known as *the granite building*.

Parrott's building, on the corner of California and Montgomery Streets, long occupied by Wells, Fargo & Co., and now the Union Club, was built later in 1852, of the same Chinese granite, and is also in perfect condition as far as the corroding influence of the elements is concerned. Still later, LeCount & Strong built the granite edifice on Montgomery Street, No. 517, which was occupied by them.

The marble building, No. 614 Washington Street, was erected in 1854, of marble imported from Vermont. It is a handsome building, but the stones are much weathered. Some of them are still perfect, from which circumstance it would seem that the material is not uniform, and was not well selected. The building was erected by Mr. Truebody, and is still owned by him.

The first California quarry opened was at Folsom, Sacramento County. Mr. G. Griffith, as early as 1853, furnished granite for Wells, Fargo & Co.'s building at Sacramento, and for the Government works at Fort Point and Alcatraz. The Penryn quarries, Placer County, were located by Mr. Griffith in 1864. Penryn is about twenty-eight miles from Sacramento, on the Central Pacific Railroad, and eight miles from Auburn, the county seat of Placer County. The following description is taken from the San Francisco News Letter:

The Penryn quarry is practically inexhaustible. The present demand, which is to the extent of ten thousand tons a year, is steadily increasing, and the orders are from all points of the coast. For external walls and inclosures, this granite is often used in the simple hewn form; but there is a growing requirement for the polished material, more particularly for sepulchral urns, obelisks, and monuments, and for the grand approaches to the more stately mansions of the wealthy. So wide has been the extension of the taste for this polished granite, that Mr. Griffith has built at his quarry a large polishing mill, the only one of the kind in California. This is a building two hundred feet long by forty feet wide, and its present capacity, which is, however, to be largely increased, is of one hundred cubic feet per day. There are two stone polishing carriages for flat surface work, each twenty-six feet long by six feet is width, and worked by a spring wheel, which is driven by two belts. A stone of more than ten tons weight can be polished on these. The mill has also two polishing pendulums and two very powerful lathes, capable of polishing with ease a solid block of ten tons weight. Besides these there are eight vertical polishers, every kind of mold, both large and small, and of machinery for flat surfaces. The derricks are, of course, very numerous, the six largest being each able to lift twenty tons with ease.

To work the derricks and the polishing mill there are three steam engines; and the force employed by Mr. Griffith is, four blacksmiths, two carpenters, three engineers, and one hundred and fifty quarrymen and stone-cutters. Not unfrequently the numbers are very much greater, and the vast stone sheds, with their room for two hundred stone-cutters, are often found crowded. It is but lately that Mr. Griffith has opened a quarry of very beautiful black granite, and this material will be largely used in the adornment of Mr. J. C. Flood's new residence at Menlo Park, the contract for all the stonework having been made with Mr. Griffith. The buttresses which are to support the walls of this great building, according to the designs of Messrs. Laver & Curlett, the architects, are to be of carved and polished black granite; and the same beautiful material will be employed for the coping of a beautiful fountain in the grounds.

Among the more notable buildings and great public works for which the Penryn quarry has furnished the granite, are the United States Mint, the New City Hall, the New Stock Exchange, the contract for which amounted to $70,000, the Real Estate Associates building, which took to the amount of $25,000, and many of the well-known residences of city magnates, such as those of Governor Stanford, Charles Crocker, Mark Hopkins, and others. The contract for the Dry Dock at Vallejo, originally made with another party, was subsequently given to Mr. Griffith. This amounted to $130,000.

When I visited Penryn in 1880 I noticed a large pile of pavement blocks, two hundred thousand, more or less, which Mr. Griffith informed me would not pay to move, owing to cost of transportation by rail. I was specially interested in the machinery for polishing. The beautiful vase, No. (3364), in the State Museum, was cut and polished at Penryn, and presented to the State by Mr. Griffith. The work is first cut nearly into the required shape, after which it is placed in the lathe; iron molds of the form intended are held against it and fed with sand or emery and water until the form is perfect, when a polish is given by emery and oil, followed by a final application of putty powder on felt. Plane surfaces are cut and polished on a moving bed, over which pass revolving discs of iron or steel.

At Rocklin, also in Placer County, there are extensive granite quarries. The stone here is of a finer texture and lighter color than that at Penryn. Mr. Griffith owns a quarry at this locality also. At the time of my visit large blocks were being shipped to the dry dock at Mare Island. Steam engines were generally used for hoisting the blocks from the quarries, but in one case this work was done by two yoke of oxen. In one direction, parallel to natural north and south fracture, technically called "rift," the rock splits with ease. In all other directions it frequently breaks roughly, or splits with difficulty, if at all. Along the faces of natural fracture may be seen flattened crystals of white iron pyrites, in some cases oxidized to hematite or limonite.

The following tests of California granites were made at the Risdon Iron Works, of San Francisco, and are furnished by Mr. Griffith:

Three and one half by three-inch cubes	70,000 tbs crushing force.
Three and one half by three inch cubes	90,000 tbs crushing force.
Three and one half by three-inch cubes	50,000 tbs crushing force.
Penryn, three-inch cubes	72,000 tbs crushing force.

Gneiss, as before mentioned, is a stratified or foliated granite. Experiments at New York and elsewhere have shown that it is a useful and durable building stone. It is found at several localities in California; (5086) is a specimen said to be found in place on the peninsula of San Francisco, but this is very doubtful. Large quantities are sent to San Francisco by schooner from a locality I have not yet learned. The quality is good.

Mica schist is a foliated rock, consisting of mica and quartz; when the latter is largely in excess, it is called quartz schist. It is a useful building material in some cases. No. (4236) is from the Berkeley hills, and (4239), with garnets, is from the mouth of Russian River, Sonoma County.

Porphyry is a name applied to those rocks of plutonic origin, consisting of a compact base, in which crystals of feldspar are imbedded. The crystals are generally white, or light-colored, while the base is of distinct colors—green, red, gray, purple, etc. The chemical or mineralogical composition of the rock is not indicated by the name. The feldspar crystals are generally dull, and do not have the fresh sparkling appearance of the same mineral in the crystalline rocks. Porphyries are found in many beautiful varieties in California, notably in the Inyo Mountains and ranges lying east of the Sierra Nevada, and are always associated with mines of silver or lead. They are the best of building stones, and are highly ornamental and beautiful. No. (4057) is from Placer County, and is said to be found in large quantities. It is very beautiful and equal to the finest porphyries of Egypt or Europe; (4384) is an Indian mortar of porphyry found near the Forks of Salmon River, Siskiyou County. Very beautiful varieties (5161) are found in rolled pebbles at Monterey and on the beach at Pescadero.

Sandstones or freestones are sedimentary rocks quite common in California. Some varieties make the best and most durable building stones, as for instance, the Ohio sandstone used in New York City. This rock is useful also for making grindstones, and as a fire resisting material. The Pancake Mountain sandstone, of Nevada, is one of the best materials known for the construction of furnaces. It is a singular fact that sandstones have been brought to San Francisco from New Zealand, and used in the erection of buildings, when we have quite as good, and, perhaps, better in this State. (4153) is a sandstone which crops on the beach at Pescadero, San Mateo County. The same formation may be found at several other localities in that and other counties. In it petroleum is found on Tunitas Creek. The same occurs near Alma, Santa Clara County, at which locality oil wells have been sunk. (4215) is an excellent sandstone suitable for building from Eureka, Humboldt County. (4258) is a red-colored sandstone from Santa Margarita Ranch, San Diego County. 4480 is from Glenn Mills, San Mateo County. (5081) is from Sonoma County near the Great Eastern Quicksilver mine. A yellow sandstone crops on the summit of Telegraph Hill, San Francisco, which might be utilized. (1518) is an interesting specimen, consisting of the constituents of granite, with hornblende, but sedimentary, found on Telegraph Hill, San Francisco. On the road from the lime kiln to Clipper Gap, Placer County, may be seen the ruin of an old kiln near which a remarkable formation crops out on the sides of a small ravine behind the ruined kiln. It is a light colored stratified rock, dipping slightly from the horizontal, and in portions somewhat distorted. The edges of the strata are very uniform and parallel, generally about two inches in thickness where the formation is cut by the small stream. The walls have the appearance of the floor of a bowling alley. The large slabs are easily quarried, and have been somewhat utilized in building the old kiln, and in a wall at Clipper Gap. The formation is at least thirty feet in thickness, lying unconformably on a dark colored slaty rock. This rock seems to be suitable for flagging and other building purposes. The following tests were lately made on sandstones from Almaden, Santa Clara County, at the Risdon Iron Works:

Dark colored six-inch cubes	140,000 lbs crushing force used.
Light colored six-inch cubes	54,000 lbs crushing force used.

(4742), a fine brown freestone, resembling that used in New York, is from Coronado Island, twenty-five miles south of San Diego, Lower California, Mexico. Diorite, called also Greenstone, or trap rock, is a basic, plutonic rock, an intimate mixture of hornblende and feldspar, generally albite, but never orthoclase. The rock is fine textured, and usually green colored. Specific gravity about 2.7, containing from 47 to 58 per cent of silica. Diorite is very tough and hard; properties rendering it suitable for pavements and road making. It is probably better for street blocks than the basalt, now so extensively used for that purpose. There is a beautiful variety called "orbicular diorite," or "Napoleonite," because first found in Corsica, the birthplace of Napoleon, which includes globular masses of dark-colored diorite in a lighter-colored rock, but also diorite. No. (1857) is a fine specimen of this rock, from the Corsican locality, and No. (1859) is from Section 17, Township 11 north, Range 8 east, Mount Diablo meridian, eight miles from the town of Rocklin, Placer County. This beautiful stone will be highly appreciated at some future time. (3016) is a diorite of good quality, with section for microscopic study. Diorite is quite common in California, being often found as wall rock for gold and silver mines.

Lava, Basalt, Trachyte, Pumice, Obsidian, etc., are names given to igneous rocks, ejected from volcanoes. The name lava is general, and applies to all the others; many varieties have a distinct and known composition, and are recognized as rocks. Basalt is basic, while others are acidic. Volcanic rocks are very common in California. Basalt is used as a street pavement. There are many specimens in the State Museum. At Mill Creek, three miles southwest from Healdsburg, Sonoma County, there are fine basaltic columns. The same may be seen in Butte County, near Morris Ravine. Pumice stone equal to that brought from the Lipari Islands, and a deposit of the same rock, found on the south side of Lake Merced, near San Francisco, has supplied the market for a number of years.

Pozzuolana is a volcanic ash, or sand, which is extensively used as a cement, having certain properties which render it extremely useful for building purposes. When ground and mixed with water, and from one third to two parts of lime, it sets into a hard cement or mortar, and equally well under water. Mr. J. S. Hittell sent samples from Rome to the State Museum, with directions for use. A copy of the Daily Opinion of Rome, March 4, 1883, was sent with it, containing the following paper, translated by Dr. Paolo De Vecchi, of San Francisco:

New Method of Finding the Value of Pozzuolana.—One of the researches the most slow, and for industrial chemistry not always reliable, is that of determining the good quality of pozzuolana, so as to give, in conjunction with lime, a mortar of great resistance. Now, Mr. Landrin proposes a method of analysis of his own, which, in preference to those already known of Vicat and Canndenberg, has the advantage of only requiring a very short time for the experiment. In fact, Vicat's method, which consists in observing the action of the water of lime on the pozzuolana, requires, in order to obtain satisfactory results, a period of several months. The author remarks that the most careful analysis of the pozzuolana cannot determine its qualities, but only its components. But, if the pozzuolana is treated with hot chlorohydric acid, there will be obtained a soluble and an insoluble substance, and it will be seen that the latter is nearly entirely composed of silicious matter. Mr. Landrin adds that it is precisely the more or the less quantity of silica capable of being united with the lime that determines the quality of the pozzuolana. But for such determination it is not the quantity of silica shown by the analysis that must be computed, but only that which can combine with the lime. Mr. Landrin experimented on three qualities of pozzuolana, one coming from Reunion Island, one from Italy, and the last manufactured near Paris. Relying on the fact that the hydraulic silica has the property of reducing the water of lime, he treated the pozzuolana with boiling chlorohydric acid, and put a certain quantity of the insoluble substance thus obtained in water of lime. In only twenty-four hours he was thus able to ascertain that the action of this silica was such that it reduced, in the true pozzuolana, an enormous quantity of water of lime. The silica of the Italian pozzuolana reduced in that short interval about one hundred and five times its volume of water of lime. On the contrary, the French artificial pozzuolana, which to the analysis had given a quantity of silica larger than the two others, only reduced in the same interval four times its volume of water of lime. In effect this latter pozzuolana produces but an inferior quality of cement. The experiments made in comparison with the preceding methods, that is, treating not the insoluble substance of the pozzuolana, but the pozzuolana itself with water of lime, have shown that these methods can in nowise be compared with the rapidity of the one just described.

About the same time a light colored brecciated rock was brought to the State Mining Bureau, found in the hills near Berkeley, and claimed to be pozzuolana. Mr. Samuel Kellett, practical plasterer, made experiments, and announced it to be a hard setting cement, like pozzuolana. On the strength of this opinion a laudatory notice appeared in the city papers. Subsequently Mr. Kellett reversed his opinion, having made other experiments with less satisfactory results. My own experiments failed to produce a hard cement. Others claimed to have found a method of doing so, but kept the details a secret. An analysis was said to be made of this material, many years ago, by Mr. G. E. Moore, a well known chemist. This analysis is given below, No. 1, and for comparison one of the true Roman pozzuolana, by Berthier, No. 2:

	No. 1.	No. 2.
Silica	44.4	44.5
Alumina	15.6	15.0
Lime	8.6	8.8
Magnesia	4.1	4.7
Oxide of iron	11.6	12.0
Potash	1.5	1.4
Soda	3.9	4.1
Water	9.5	9.2
	99.2	99.7

It will be noticed that there is a striking similarity. It may be that subsequent experiments may show that the rock is really pozzuolana, in which case it would be a very valuable material to be used in building. If this should fail to give satisfactory results, some of the other volcanic materials may prove to be this most desirable cement.

Serpentine is a hydrous silicate of magnesia, described elsewhere. It is abundant in California, being generally associated with chromic iron, and magnetite, hematite, limonite, etc. It is more an ornamental than a building stone; slabs for interior work are both beautiful and durable. It is much employed in Europe in combination with marble. It is a metamorphic rock, and not, as formerly supposed, of eruptive origin. Verde antique is a beautiful green serpentine, mixed with carbonate of lime, and colored by oxide of chromium. There are reasons to hope that this rock may yet be found in California.

Limestones, including *Marble*, *Travertine*, and *Tufa*. These rocks make excellent building stones; they will be fully described under the head of Calcite.

Dolomite is a magnesian limestone, abundant in California, and well adapted for building purposes, fully described under the head of Dolomite.

Slate is a useful and very durable building material, generally used as a covering for roofs, and sometimes for the sides of buildings, to render them fireproof. The slates are silicious sedimentary rocks; one cubic foot weighs from 170 to 180 pounds.

The following is from the second annual report, 1882, folio 96:

Both slate and shale are, no doubt, sedimentary mud or silt, which, from great age, have become indurated and in most part were formed at the bottom of the sea. The fossils contained in them are conclusive evidence of this. Natural forces have bent and warped the strata until they have become plicated like the leaves of a book, or a pile of writing paper pressed laterally. In slate quarries lines of stratification of various colors may be seen marking the different periods of deposit; the lines of cleavage lie generally in a certain direction, which is called the strike; the inclination is called the dip; they were all laid in horizontal strata. Slate is altered shale: instead of cleaving in the plane of stratification, as shale invariably does, it now divides at an angle with the natural deposition. The new lines of cleavage are called cleavage planes. The line of strike in the slates is almost invariably parallel to the trend of the mountains, and the upheaval in the surrounding country, from which may be inferred that some lateral pressure has bent the strata and caused at the same time the slaty cleavage.

To prove this, Mr. Sorby, of London, made some interesting and conclusive experiments bearing on this subject. He subjected a portion of clay without cleavage or stratification to very great pressure. The original mass contained scales of oxide of iron, which were distributed throughout the clay without regularity. The clay was reduced by the pressure to half its volume. The result of these experiments was the development of certain singular phenomena. The scales of iron oxide had arranged themselves in parallel lines, and a slaty cleavage was now apparent, and singularly, the cleavage planes were at right angles with the pressure applied. Professor Tyndall has shown that pure white wax can be made to cleave into parallel scales if sufficient pressure is applied. Were these experiments not sufficient to prove that slate, unlike shale, has been under great pressure, other facts may be stated.

In the silurian slates of Europe the imbedded fossils are frequently distorted, and the elongation is always in the direction of the cleavage planes, showing that the movement of particles which caused the lamination was in the line of least resistance, or at right angles with the pressure. When there are no fossils present, small gravel and pebbles are found to be arranged like the iron scales in Mr. Sorby's experiment, with the longest axis in the direction of the dip. When neither fossils nor large particles are present, a thin slice placed under the microscope will show the finest particles and accidental scales of mica arranged in the same manner. It may be assumed that any fine grained sedimentary rock submitted to sufficient pressure by the forces of nature, will develop the same slaty structure.

Good slates are found in California. Any future demand for this indispensable building material will be filled from localities already known. No. (315) is from a cropping between Cave City and San Andreas, Calaveras County. In Oregon Gulch, near the Sunrise Copper Reduction Works, section four, township four north, and range ten east, there is an outcrop of very good building or roofing slate, which is convenient to the new San Joaquin and Sierra Nevada Narrow Gauge Railroad, which will supply this material when required. No. (4079) is from Placer County, near Emigrant Gap; (4959) is from Butte County, near Red Hill. In San Bernardino County, at Slate Range, slates suitable for building purposes, perfectly straight and of large size, are found in unlimited quantities.

Artificial Stones are made in California, and, as far as experience goes, they last very well and give satisfaction. For sidewalks, cement is extensively used.

Ransome's Concrete is largely employed for foundations.

Stone-cutting.—Sundry machines have been invented to supersede the toilsome work of hand-cutting, but there is a wide field for invention in this direction, and pecuniary reward to the inventor who will produce a perfect machine for dressing hard stones.

A machine was exhibited in the British section of the Paris Exposition of 1878, by Brunton & Trier, Wellington Road, Battersea, London, S. W., who claimed to do all work with their machine that could be required. Rotating diamond-cutters have been used in the dressing of marble, and the sand-blast employed in sculpturing very soft stones. In 1876, in Philadelphia, chilled iron in globules was used in sawing granite instead of sand with considerable success. In Boston in 1879 a machine was set up by which it was claimed that granite could be planed like wood. As these machines are not used practically to any great extent, it is fair to infer that they do not meet the requirements of stone-cutting, and the coming inventor has still an open field.

Buhr Stone—see Quartz.

25. CALAVERITE. Etym. "*Calaveras County*," where first found; see also Tellurium.

A rare mineral described by F. A. Genth, in 1868. First found in the Stanislaus mine. It is a telluride of gold and silver, having about the following composition:

Tellurium	56.00
Gold	40.92
Silver	3.08
	100.00

In a paper "on some Tellurium and Vanadium minerals," read before the American Philosophical Society, August 17, 1877, Professor Genth published an analysis made of a specimen from Colorado, in which he obtained nearly the same results, and found the hardness to be 2.5; sp. gr. 9.043; color, bronze yellow; brittle. B. B. on ch. yields a globule of gold, coloring the flame green. It is soluble in nitro-muriatic acid, except the silver, which is changed into an insoluble chloride.

This mineral occurs sparingly in the mines of Carson Hill near Angel's, at the Morgan mine with massive gold, at the Melones mine, Calaveras County, and at the Golden Rule mine, Calaveras County.

26. CALCITE. Etym. "*Calx*"—lime (Latin). Carbonate of Lime, Calcareous Spar, Calc Spar, Dogtooth Spar, Iceland Spar, Limestone, Lithographic Stone, Marble, Stalactite, Stalagmite, Travertine, Tufa, Thinolite, Anthraconite, etc.

This is a very abundant mineral in nature, being found in many varieties. It is carbonate of lime having, when pure, the following composition (CaO, CO_2):

Carbonic acid	44.0
Lime	56.0
	100.0

Atomic weight (50); sp. gr. 2.5—2.8; H. 2.5—3.5; infusible, but when heated becomes caustic, and colors moistened turmeric paper brown. In point of blowpipe flame, it glows with brilliant white light (lime light), dissolves in acids, with effervescence. The solution made alkaline with ammonia, throws down a white precipitate with oxalate of ammonia, and also with carbonate of soda. Lime is an oxide of the alkali metal *Calcium*, one of the most widely diffused elements, being found in the animal, vegetable, and mineral kingdoms, always combined with other elements, singly or in groups. In the mineral kingdom it is found as carbonate, sulphate, silicate, tungstate, or fluoride, and as a constituent of many complex minerals. Lime has been known and utilized from the earliest ages. Calcium was discovered in 1808 by Sir H. Davy. It is a light yellow metal, the color of silver gold alloy, having about the hardness of gold, and when freshly cut considerable luster. Unless protected from oxygen, it soon oxidizes and loses its metallic character. It is very light, the sp. gr. being only 1.5778. It is very ductile, and may be hammered into sheets as thin as paper. It is obtained by the following methods: Chloride of calcium, in the presence of mercury, is subjected to the action of a strong current of galvanic electricity, when the metal calcium is reduced and combines with the mercury in the form of amalgam. This is heated to redness in an atmosphere of hydrogen, or vapor of rock oil. The mercury is sublimed, leaving the calcium in a metallic state. Or the following: Two equivalents of chloride of calcium and one of chloride of strontium, with a little chloride of ammonium, are fused in a small porcelain crucible while subjected to a strong current of galvanic electricity. The calcium forms in small beads, which are removed from time to time.

The metal dissolves in water, forming lime water, decomposing a portion of the water in doing so, and setting hydrogen free. The atomic weight of calcium is 20, and the symbol Ca. By the new system the atomic weight is 40, or double the old. Lime, also called *caustic* lime is the oxide of calcium, as before mentioned, written Ca O, or one equivalent of calcium and one of oxygen.

Calcium, Ca.	20
Oxygen, O.	8
	28

It is commonly prepared by strong and long continued ignition of natural carbonate of lime (limestone); it is less frequently obtained from oyster shells, coral, chalk, and in California and Nevada from thinolite, a tufaceous mineral found in the beds of ancient alkaline lakes. Pure limestone cannot be over-burned, even when subjected to the strongest heat; but when containing clay or other impurities, it may be *dead-burned*, and rendered useless by too great a heat. When caustic or quicklime is mixed with water an intense reaction results. Heat is evolved, and a chemical combination of the water with the lime takes place; the lime is then a hydrate, or slaked lime, thus (CaO, HO):

CaO	28
HO	9
	37

Lime is almost indispensable in building and the arts, and California is fortunate in having an abundance of limestone within her borders, not only as a source of lime, but in the form of beautiful marbles mentioned elsewhere. Most limestones have been formed on the bottom of the sea, from shells and corals, which are often found imbedded in it as perfect in form as when alive. Some of these limestones have so changed (metamorphosed) that they have become crystalline, and sometimes veined by foreign substances they contain, while at others they are as pure and white as snow. They are then called crystalline limestone or marble.

LIME—MANUFACTURE AND PRODUCT IN CALIFORNIA.

If limestone occurs sparingly in Oregon and perhaps also in Washington Territory, as stated by Williams in his work on the Mineral Resources of the United States, there is still known to be enough of it in these countries for all practical purposes. In all the Pacific States and Territories there is sufficient lime manufactured to meet local requirements. For a time after the American occupation of the country, including the early mining era, not much lime, cement, or plaster was used in California; the buildings put up during that period having been mostly constructed of wood, the walls and ceilings being covered with cloth and paper instead of plaster. But few houses with brick chimneys, and still fewer with brick or stone foundations, were then to be seen. The destructive conflagrations that occurred so frequently in those early times calling for a more substantial style of buildings, lime in considerable quantity became a necessity. To supply such want the manufacture of this article was begun as early as the Spring of 1851, when a Mr. Shreeve commenced burning lime at the Mount Diablo quarries, near Pacheco, Contra Costa County, he having been the pioneer in the business under the new regime, for this was one of the few industries practiced by the Spanish settlers in California before the country changed hands. Though carried on in a small and primitive way, these people made a tolerably good article of lime, as is attested by the durability of some of their buildings and the manner in which the whitewash they applied to them has withstood exposure to the weather.

In the month of June, 1851, Mr. Davis, of the firm of Davis & Cowell, San Francisco, started a kiln in the hills back of Mayfield, Santa Clara County. Mr. Davis, who came so near being the pioneer in this business, has continued it ever since, having for many years past been the largest manufacturer of this commodity on the Pacific Coast. Gradually, as towns and cities sprang up, and new industries were multiplied, the business of lime burning from these small beginnings extended to other parts of the State, until nearly every populous neighborhood containing the stone came to have its kiln, whereat enough lime was made for home purposes. During the three or four years that followed the gold discovery, the little lime required here was imported from the Eastern States. Owing to danger from spontaneous combustion on the voyage, this lime was slaked before being shipped, and arrived here in a condition much resembling putty.

THE PRINCIPAL LIMESTONE BELT OF THE STATE.

While limestone occurs in many parts of California, the principal deposit consists of a belt of this rock extending along the westerly foothills of the Sierra Nevada, traversing in a northerly and southerly direction the main gold field of the State. This belt, which reaches from Mariposa County to Butte, a distance of 150 miles, varies in width from two or three hundred yards to several miles. In the vicinity of Columbia this rock consists of a good quality of marble, susceptible of taking a high polish. A metamorphic limestone is found at intervals for hundreds of miles along the Coast Range of mountains. From this source the towns and counties on the seaboard obtain most of their supplies, the foothill belt supplying the central mining regions and the great agricultural valleys adjacent on the west. On this belt, in El Dorado County, are located the "Alabaster Lime Works," consisting of a "Monitor" kiln having a capacity to burn 3,000 barrels per month. The property owned by the H. T. Holmes Company embraces what is known as the "Alabaster Cave," one of the natural curiosities of California. The lime made at this locality is noted for its purity and whiteness, and being well suited for the purification of gas, is used by several gas companies in the interior for that purpose. The kilns near Clipper Gap, Placer County, also owned by the Holmes Company, and at which a good deal of lime was formerly turned out, having been closed down for the past two years, no lime has in the interim been made there.

DEPOSITS AND WORKS IN SANTA CRUZ COUNTY.

The principal lime district in the Coast Range and the most productive locality in the State is situate near the towns of Felton and Santa Cruz, in Santa Cruz County, where there occur extensive beds of crystallized limestone of superior quality. At this point several companies have put up works, each having large capacity. The plant of the H. T. Holmes Company, who are operating near the town of Felton, consists of five large kilns, two of them being of the improved Monitor pattern. In 1883 this company made here about fifty thousand barrels of lime, hardly more than half what they were capable of doing. The product of their kiln, in El Dorado County, amounted, for the year, to about fifteen thousand barrels, operations there having been suspended during the Winter. Blochman & Cerf, whose works are also near Felton, turned out during the year about the same quantity as the Holmes Company, though they, too, have capacity to make more than twice as much as they have done for several years past. The works of Davis & Cowell, near the town of Santa Cruz, comprise six kilns of the old fashioned style. This firm also makes a good deal of lime at Cave Valley, five miles south of Auburn, Placer County. This lime, answering well for glass-making, is used by the San Francisco and Pacific Glass Company, at their works in this city. About three fourths of all the lime that comes to the San Francisco market, and one third of all that is produced in the State, is made in the vicinity of Felton and Santa Cruz, where the facilities for manufacturing and shipping this article are extremely good. The stone here, besides being plentiful and of the best kind, can be easily quarried. Wood and water are abundant, and shipments can be made either by rail (the South Pacific Coast Railroad running within a mile of the quarries), or by vessels through the port of Santa Cruz, twelve miles distant from Felton. From the redwood trees that abound in the neighborhood a good barrel can be cheaply made for putting up the lime. This Santa Cruz lime, of which two kinds are made, common and finishing, is held in good repute, both for its strength and finishing qualities. These several companies employ from thirty-five to forty men each, this number including quarrymen, wood choppers, teamsters, etc.; wages, $1 50 per day, though much of the work is done on contract.

In the Hydro-Carbon Lime Works at Colton, San Bernardino County, petroleum is being used as fuel, and, as it appears, with success. Whether the experience had here would be of universal application is questionable. Where other fuel would be rather dear and petroleum rather cheap, as at Colton, there might be economy in burning the latter, while there would be none were these conditions reversed. Further experimenting may be required to establish the value of petroleum as a fuel for burning lime, even at Colton.

PRICE AND PRODUCTION IN THE PAST.

For a time, at first, lime sold in San Francisco for as much as eight or ten dollars per barrel. But these extreme rates did not hold for more than a few years—home competition having gradually reduced prices to the very moderate rates that for a long time have ruled everywhere on this coast. As many as twenty years ago lime sold in this city at $2 25 to $2 50 per barrel; about one dollar more than present rates. The receipts of lime at San Francisco during this period were, approximately, as follows; the entire quantity being the product of this State:

Year.	Barrels.	Year.	Barrels.
1863 (estimated)	74,000	1874	143,513
1864	73,553	1875	182,631
1865	90,037	1876	174,758
1866	89,786	1877	155,113
1867	102,708	1878	144,072
1868	125,157	1879	104,405
1869	119,266	1880	133,097
1870	105,342	1881	123,779
1871	111,574	1882	133,306
1872 (estimated)	112,062	1883	158,035
1873	143,513		

The prospects of the lime-making interest for the incoming year are considered tolerably good. The quantity of lime made in the United States in 1882 is given at 31,000,000 barrels (of 200 pounds each), having a total value at the kilns of $21,700,000.

The "Monitor" lime-kiln consists of a cylinder of boiler iron, lined with fire-brick. It is usually located on a hillside, so that the limestone can be run from the quarry by means of an elevated tramway to a door in the upper part of the kiln, ten to twenty feet above the fire. Above the cylinder an iron smokestack rises twenty to thirty feet to insure a draft; below the cylinder are the fire-places, consisting of a number of fire doors opening into converging openings, in which wood is burned over ashpits, into which the ashes fall through gratebars. The limestone is fed into the upper door and drawn out, when properly burned, through a lower opening below the fires, at which point it is shoveled into barrels. The advantage of the Monitor lime-kiln over the old-fashioned style consists in the fact that the former can be run continuously, whereas with the old kind, when a batch of stone has been burnt, the fires must be extinguished, and renewed after the kiln is again filled with stone. This, besides the trouble of putting out and relighting the fires, causes considerable loss of time. The cost of the Monitor kilns varies from three to five thousand dollars, according to capacity.

Limestones, including the variety known as marble, are found in considerable abundance in several parts of the State, as before mentioned. The following counties are represented in the State Museum:

Amador County (4894).—White marble, nine miles north of Ione; good building stone.

Butte County.—Blue limestone, or marble (4376), near Pence's ranch, extends several miles. Found by Prof. Whitney to be carboniferous; the fossils found were *Spirifer lineatus* and *Productus semireticulatus.* This limestone would no doubt make a good building stone. It is soluble in hydro-chloric acid with effervescence, leaving a small hepatic residue. When struck with a hammer it emits a fetid odor (anthraconite), burns to a pure white lime which slacks perfectly; at the time of my visit I looked very carefully but found no fossils.

Calaveras County.—Pearl gray marble (3387), with dark markings; highly polished; from a large deposit. A beautiful marble and valuable building stone.

El Dorado County.—At the Alabaster Lime Works, so called from the whiteness and purity of the limestone, situated near Newcastle, Placer County, which is the shipping point on the Central Pacific Railroad, the limestone, or marble, varies from a pure white to an agreeable gray color, and takes a high polish. The lime is of excellent quality, and the stone would doubtless make a valuable and durable building material. The lime is generally shipped in bulk, and by the carload of ten tons, and sold in Virginia City, Marysville, Red Bluff, Chico, Sacramento, and San Francisco. The Folsom Prison is entirely built with this lime. Mr. Ewing, the Superintendent, found some fossils, or what he thinks were fossils. From his description they may have been encenites, but from the metamorphic character of the rock I am inclined to doubt it. The quarry, which is across the stream from the Alabaster Cave (to be hereafter described), was opened in 1877. The face of the quarry is eighty feet high. The floor is thirty feet above the lower floor of the Monitor kiln, which has a capacity of three thousand barrels per month. The old stone pit-kiln, first used, was on the side of and near the entrance of the cave. Another, and larger one, was built in 1862. Five tons of lime are hauled at a load, one trip per day, in four wagons, drawn by two teams of horses.

Humboldt County.—A beautiful mottled gray marble has just been brought to the State Museum from near Eureka. It is soluble in acids, leaving but a small residue, contains but little magnesia, takes a high polish, has a uniform texture, and seems to be an excellent marble.

Inyo County.—In the Inyo range, on the east side of Owen's Valley, there are large outcrops of limestones and marble, from nearly black to pure white. These mountains promise a plentiful field for future research, and a thorough study of them will probably throw much light on the geology of the State. Marble is also found in the foothills of the Sierra Nevada. At "Big Pine" there is a cropping of beautiful white marble, of which there is a cube, cut and polished, in the Museum. No. (3669) is a peculiar formation. The following is the Museum label:

Rock Specimen—Locality, Inyo Range, 2,000 feet above Owen's Valley, Inyo County, Cal. Of peculiar interest, consisting of alternate layers of quartzite and limestone. On the weathered surface the limestone has been cut away, probably by the action of drifting sand, while the quartzite remains clear and sharp. This specimen is an interesting study, the question suggesting itself how the two minerals were deposited so evenly and with such alternate regularity. When found, the strata were vertical.

No. (4654) is limestone containing fossil corals, weathered by drifting sands, found in Death Valley.

Kern County.—No. 5019 is a water-worn bowlder of limestone of good quality, found on Posa Creek. The deposit is not known.

No. (710) is a beautiful brecciated yellow marble, from Tehachipi, which will some day be much prized. Onyx marble (aragonite, 2327) is found at a mineral spring six miles above Kernville.

Lithographic stone (2789) is found in this county. The exact locality is southeast quarter of Section 12, Township 32 south, Range 34 east, Mount Diablo meridian. The mineral, which is a compact yellow limestone, is said to exist in large quantity, cropping out for half a mile.

While a variety of lithographic stone has been observed at several places in California, none has yet been found of a quality suitable for the uses of the artist. The defects of the California stone do not, however, consist, as is the case with most of that found elsewhere in the United States, in its being brittle, coarse grained, or lacking in uniformity of texture, but in want of hardness. In other respects some of the samples experimented with have given tolerable satisfaction, leading to the hope that when our quarries come to be opened to greater depths the quality of the stone will so improve that it can be used for some and perhaps all purposes. Some specimens of lithographic stone found at the Kern County locality, brought to this city not long since, were pronounced by experts of a better quality than any before obtained in the State. As a stone of this kind, that will answer for fine, or even ordinary work, commands good prices, our prospectors and miners should be on the lookout for such material, while pursuing their vocations. The value of the lithographic stone imported into this State amounts every year to a considerable sum, the total imports into the United States amounting annually to about $120,000.

While this material is found in several States of the Union, notably in Iowa, Alabama, Kentucky, Missouri, and Tennessee, and also in England, France, Italy, Canada, and the West Indies, no first class stone has ever been obtained, except from the quarries of Solenhofen and Pappenheim, in Bavaria. The product of these quarries consists of a fine grained, compact limestone, which is prepared for the artist's use before being sent to market. As the Bavarian stone is costly, with a constant tendency toward higher prices, while its quality is said to be deteriorating, the stone of other countries may, with all its faults, be expected to grow steadily into larger use.

Los Angeles County.—Specimens of limestone or marble from this county were presented to the State Museum by Mr. J. A. Christy. There are two varieties—one light colored, the other dark. They are burned for lime in common pit kilns. Two kilns yield six hundred barrels of two hundred and seventeen pounds at a charge. The old padres burned this limestone, and used it for plastering and whitewashing. Some walls are reputed to be two hundred years old. The quantity is said to be unlimited.

In Monterey County, near Carmelo Bay, a fine white marble is found. Some years ago, the Pacific Carrara Marble Company was incorporated to work this deposit.

Nevada County.—A dark gray, veined marble occurs at Bear Creek, three miles from Colfax. There is another locality ten miles south of Grass Valley, where the same lime has been burned. The limestone is carboniferous.

Placer County.—Limestones and marbles are rather abundant in this county. Several deposits of excellent marble are known near Auburn. (1939) is from a cropping near the iron works, Section 15, Township 13 north, Range 8 east, Mount Diablo meridian. It is white saccharoidal. It has been largely used in San Francisco in the manufacture of mineral waters. It could be cut into large slabs if required.

ANALYSIS.

Silica	0.15
Sesqui-oxide of iron	0.35
Lime	55.72
Carbonic acid	43.78
	100.00

There is a cropping of very compact black limestone (marble), veined with white (2799), within a few feet of the Central Pacific Railroad, near the high trestle a mile or more above Colfax, which has at some time been burned for lime, in a rude experimental kiln, now fallen into decay. The work done at this point has not been sufficient to show the extent of the deposit. A careful examination failed to reveal any trace of fossils. This is not only a beautiful ornamental marble, but is a good and accessible building stone. The Museum specimen has been cut in cubic form and polished. There is a fine cropping of limestone, light gray, with darker gray markings (2807) half a mile below Auburn, on the American River. It is singular that no attempt has been made to utilize the beautiful stone found in this quarry, for building purposes; all the conditions for cheap working are found combined. The river, running a few hundred feet below, would furnish unlimited water power and pure quartz sand. The same power would lower the rough blocks from the quarry to the works at the river, and elevate the finished work to the level of the railroad above the quarry, by tramway and cable. There seems to be no reason why works should not be constructed for the manufacture of marble slabs, mantels, plumbers' goods, etc., to be shipped by rail to a market in a finished state.

ANALYSIS.

Silica	.25
Ferric oxide	.25
Magnesia	Trace.
Lime	55.72
Carbonic acid	43.78
	100.00

There is also a large deposit of similar marble (1863) near Clipper Gap. The following analyses were made of different samples from this locality:

	No. 1.	No. 2.
Silica	Trace.	0.15
Ferric oxide	0.05	0.35
Magnesia	Trace.	Trace.
Lime	55.97	55.72
Carbonic acid	43.98	43.78
	100.00	100.00

(1866) is a white marble from Cave Valley, near Auburn.

Plumas County.—Limestones and marbles are found at Devil's Elbow and Indian Creek in this county, but the Mining Bureau has no special information concerning them.

San Bernardino County.—Limestones are found at several localities in this county, but the most important is near Colton, where lime has been somewhat largely manufactured. The quarries lie in Slover Mountain, half a mile from the town. There are several varieties, the best being a very white fine textured marble. The rock from which the lime is made is gray. There are quarries of limestone also in the San Bernardino Mountains.

San Luis Obispo County.—There are numerous localities of limestone in this county, but little is known of them. The "Onyx" marble has been fully described under the head of Aragonite.

Santa Cruz County.—(2005) and (4147) are marble or limestone of good quality, from the quarry of Davis & Cowell. The lime from this county has been described under the head of Lime. (3372) is a concretion of limestone with diaphragms of harder material, probably silicious. The whole bearing a strange resemblance to a fossil turtle, found seven miles northeast of the town of Santa Cruz. These concretions, known as turtle stones, are not uncommon elsewhere.

Shasta County.—Extensive beds of carboniferous limestone are found in the Gray Mountains, which extend far north along the McCloud River. No doubt these deposits would furnish fine building and ornamental stones. The interesting carboniferous fossils found in these limestones, were first discovered by Dr. Trask, in 1855, and are mostly figured in the first volume of the Paleontology of California, Whitney's Geological Reports.

Tuolumne County.—This county contains extensive beds of limestone and marble. (267) is a beautiful dark mottled marble, from Abbey's Ferry. (904) is a white and beautiful marble, exact locality not given. (3604) is a gray marble from the bed of the Tuolumne River. At Sonora, in the river bed, a beautiful gray marble is found in large bowlders, which have been uncovered in placer mining. There is a deposit of blue limestone near York Tent which makes excellent lime. The Odd Fellows' Hall, Sonora, is laid in mortar made from this lime.

Carbonate of lime is soluble to a slight degree in pure cold water, and more so when carbonic acid is present; water in a limestone country is generally in this condition. In percolating through a calcareous formation, water bears away a notable portion of the rock in solution, which, continued through a geological period of long duration, manifests itself in cavernous openings generally known as *caves.* These caves are found in all limestone countries, and are not wanting in California. There is a charm about these openings in the earth, to the human mind, that is to me quite unaccountable. Most persons delight in exploring a natural cave. They experience a thrill of pleasure, mixed with dread, as they penetrate deeper into the earth and see for the first time gloomy caverns, artificially lighted by the lamps they carry. For this reason caves of any great extent are generally made places of resort, and for the same reason primitive man, and man in more recent times selected such as natural tombs for the dead. In ancient times, in Southern Europe, Asia, and Northern Africa, artificial caves were made under the name of tumuli. A chamber of stone, sometimes exquisitely sculptured and of the finest marbles, was built on the surface of the ground, in which the body of the dead was laid, after which a mound of earth and stones was built over it, sometimes several hundred feet high and covering many acres. Similar tumuli were built in Northern Europe, but of inferior workmanship, and the Eastern States of the American Union are covered with such, many still rising to a considerable height, while others have been leveled by the hand of time.

The caves of California have been in past times used as sepulchres, as attested by the human bones found in them. This was noticed by those who first came to the State after its acquisition by the United States, and it is probable that the Calaveras River was named from the finding of skulls in some cave on its banks. D. C. F. Winslow, writing to the California Farmer as early as 1854, mentions a small cave on the Stanislaus River in which human bones were found. An old Indian informed him that the bones had been placed there during a recent period. In August, 1881, I visited a cave then rediscovered in Calaveras County which contained a large quantity of human bones. I hoped to find some relics that would throw some light on the history of the human race in this country, as similar discoveries have done in Germany, France, and elsewhere, but was disappointed, for nothing was discovered to show that the bones were not those of Indians which had been laid there within a period not exceeding a part of a century. Besides these, nothing was found beyond some charcoal which formed, probably, the torches of those who came to deposit the dead; although two men worked for a number of days, washing the earth of the floor in mining pans, by which any prehistoric implements would have been recovered, had any existed, no discovery of interest was made. This cave, near Cave City, was named "The Cave of the Catacombs." In exploring it, names of visitors were found dating back to 1850, at which time there must have been another opening now unknown. Some of the bones were brought to San Francisco and placed in the State Museum. The sensational articles which appeared in some of the papers at the time, to the effect that this cave had been at one time a prison, in which men, women, and children had been driven to perish by starvation, were wholly without foundation. Cave City, once a celebrated and fruitful placer gold mining locality, was so called from a cave in the limestone, now known as the "Crystal Cave." The town once contained one thousand inhabitants.

"Crystal Cave," according to J. M. Hutchings, was discovered accidentally in October, 1850, by Captain Taylor. It is a very interesting natural curiosity, and at times has been quite celebrated, and has had many visitors, as the books of record show. At the time of my visit it was owned by George Nichols, who was just building a commodious hotel. No effort was made to attract visitors, although it is well worthy of attention, and should be made a place of resort for tourists, who would in the meantime see something of the country on the route to and fro. The "Alabaster Cave," El Dorado County, is nearly equal in beauty to the "Crystal Cave," and is more accessible, being near the great Central Pacific thoroughfare. It is situated six miles southeast from Newcastle, on Section 15, Township 11 north, Range 8 east. It was discovered April 16, 1860, by two workmen, George S. Hatterman and John Harris, who were employed by William Gwynn in quarrying and burning lime. In blasting, they discovered a small opening which led to the cave. The first description was written by Mr. Gwynn, and appeared in the "Sacramento Bee." For a time the cave was visited by many persons, but at the time of my visit, few came to see it; four thousand seven hundred and thirty names were registered and numbered, after which the numbering was discontinued. The really good hotel has fallen into decay. In both the above-mentioned caves, numerous stalactites and stalagmites may be seen, and I observed that on the end of each stalactite there was a drop of water. It is curious to consider that these excavations have been made by the slow, solvent action of water falling drop by drop, and that the same process is going on to-day, but is imperceptible to the senses. Some faint idea may also be gained of the great age of these limestone rocks by considering these facts. The drops do not form rapidly, the tip of the stalactite must be watched for some time before the fall will occur, and considerable time passes before another drop of water takes its place. This slow operation has been going on for centuries. Who can tell when it will cease? The limestone at "Alabaster Cave" is generally faintly blue, and clouded, but some portions are pure white, and appear translucent when a candle is placed behind a thin stalactite. I did not determine the thin comb-like edges of slate which project from the marble ceiling, being less soluble than the limestone. They sometimes resemble the tables on the face of a glacier, but are of course inverted. Bower Cave, in Tuolumne County, on the road from Coulterville to the Yosemite Valley, scarcely deserves the name, being more a grotto than a cave, and more a fissure in the limestone than either. It was frequently visited by tourists in former years, but has now passed from notice. Pluto's Cave, Shasta County, is described by Professor Whitney (Geology of California, volume 1, folio 351) as being very interesting, but it is in lava and not limestone. The manner of its formation is doubtful. On one side of the great limestone croppings near Clipper Gap, there is a small cave extending nearly through the mass, which has been rendered historical as the residence of a band of robbers in early times. It would be interesting to examine the floor for prehistoric remains and bones of animals.

There are specimens of stalactite and stalagmite in the State Museum, from "Bass Cave," Shasta County (1129, 1130), San Luis Obispo County (2817); cave near Volcano, Amador County (3722), and a large number from the Crystal Cave, Calaveras County (133, 3009, 4791).

Iceland Spar is a perfectly transparent calc spar, first found in Iceland. It is used in optical instruments to polarize light. By a singular property a ray of light passing through a crystal, in a certain direction of the rhombus, large or small, into which it naturally breaks, is divided into two, and both are polarized. This phenomenon is called double refraction. If a rhomb of Iceland spar is laid on a sheet of paper, upon which a single dot is made, there will appear *two*. For optical use the rhomb is split into two parts, and recemented with Canada balsam, by which treatment the dispersing power of the crystal is increased, and one ray thrown out of the field. The crystal then becomes a nicol-prism, a full description of which and mode of use will be found in works on optics. Good specimens of this variety of calcite have been found in California. One locality (3709) is Darwin, Inyo County, and another (4452) Santa Clara County.

Dogtooth Spar is a variety of calcite, in which the crystals have a fancied resemblance to the teeth of dogs. Good specimens have been found at Cerro Gordo (Aaron), and on the peninsula of San Francisco.

Tufa, or *Travertine*, is generally deposited by calcareous springs, and sometimes in the bottom of lakes, rivers, or seas holding much lime in solution. The name "Tufa" is derived from the Latin, *tofus*, and "Travertine" from *Lapis Tiburtinus*, from Tibur, an ancient town of Latium. "Tiburtine" became corrupted in time to "Travertine." This mineral occurs in several localities in California, but has not been analyzed, which leaves it in some doubt.

Thinolite is a form of calcite, a pseudomorph after Gay-Lussite, and forms in immense masses in the beds of alkaline lakes in California, Nevada, and in fact, all the great inland valley between the Sierra Nevada and the Rocky Mountains, known as the Great Basin. It was named by Clarence King, fol. 508, Systematic Geology, Vol. 1 U. S. Geological Survey of the Fortieth Parallel, and an analysis is given, fol. 823, Vol. 2, Descriptive Geology. *Thinolite* is really a tufa, being deposited in the same manner. When first found it was thought to be fossil coral, and was so described. It was first found in Mono and Owens Lakes, and in the beds of ancient lakes in the Colorado and Mohave Deserts. Thinolite from California localities is represented by Nos. 1680 and 3697, the former from Lassen County and the latter from the Colorado Desert, San Diego County.

Calcite is found in many localities in the State in small quantities, often in mineral veins with gold and ores of silver, lead, copper, zinc, quicksilver, etc., and in many varieties.

Black Calcite (2162) is found in Amador County, near Volcano; *Blue* (2004), Santa Cruz County; *Pink* (4069), Catalina Island; with quartzite (3669), Owen's Valley, Inyo County; Arenaceous, resembling the Fontainbleau mineral (3440), forty feet under the Klamath River, Thomas Middleton's Tunnel, Siskiyou County; with cuprite, malachite, and melaconite, San Amédio Ranch, Coast Range; with cinnabar (2279), Guadalupe mine, Santa Clara County, at Almaden mine, same county (1741), and at Chapman mine, same county (1224); with bitumen (1676), New Almaden; with silver and lead (2173), Modoc mine, Inyo County; with gold (4553), near Mud Springs, El Dorado County, and (4600) Palma mine, Cerro Gordo, Inyo County; and in crystals, Argus Mountains, Inyo County.

Carbonate of Copper—see Malachite and Azurite.

Carbonate of Iron—see Siderite.

Carbonate of Lead—see Cerusite.

Carbonate of Magnesia—see Magnesite.

Carbonate of Soda—see Natron.

Carnelian—see Quartz.

Cat's Eye—see Quartz.

27. CASSITERITE. Etym. "*tin*" (Greek). This mineral is the Binoxide of Tin. Sn O_2—atomic weight, 74.

Tin	78.67
Oxygen	21.33
	100.00

It is found in nature both crystalline and amorphous. In the former state it occurs in veins intersecting granite, gneiss, mica schist, porphyry, and other rocks. In the latter condition it is found in rounded nodules or grains, from several pounds in weight to the finest black or brown sand. This is called stream tin, because it is found in placers like gold, in the beds of streams, into which it has been washed by the action of water, resulting, like placer gold, from the disintegration of rocks which contained it in veins, its great specific gravity (6.4 to 7.1) causing it to resist the force of the water which has washed away lighter minerals. Stream tin is found of various colors and texture, being black, brown, drab, or nearly white; perfectly compact and amorphous, laminated, mamillary, or botryoidal, with elevated points (toad's eye tin), fibrous (wood tin), concentric, radiated, etc. H. 6—7; luster, adamantine when crystallized, stream tin dull, nearly transparent to opaque. Tin is also found in nature as a sulphide, but is comparatively rare. It has been found also in meteoric stones.

Cassiterite is easily reduced to the metallic state in a crucible with carbonate of soda and anthracite coal dust (culm), or cyanide of potassium. The crucible should be allowed to cool, and then be broken to remove the button of tin; for this operation a hot fire is required. B. B. on ch. easily reduced if the following plan is adopted: The ore supposed to contain tin should be pulverized and passed through a 40 or 60 mesh sieve, the resulting powder washed in a pan or horn spoon to a small quantity, the *prospect* dried and ground in an agate mortar with twice its bulk of carbonate of soda. This mixture is transferred to a cavity in a piece of charcoal, and heated in the R. F. until the assay assumes a spherical form, more is added until a globule is obtained half the size of a pea; a small piece of cyanide of potassium of about equal size is then placed with it, and both strongly heated in the R. F.; globules of tin will immediately appear if the metal was present in the ore, which by a little skillful manipulation may be made to coalesce into one, or the assay may be cut out of the charcoal with a knife, and ground with water in an agate mortar, when the beads will flatten into small discs under the pestle, and may be separated by washing. To be sure that the metal is really tin, the following experiment may be made: Place the bead on clean charcoal without fluxes, and heat first in the reducing and then in the oxidizing flame. If tin it will lose its metallic character and become a white oxide, which it will be found very difficult to reduce again to a metallic globule. This may be effected by the addition of a small piece of cyanide of potassium. Observe that no distinct coating is formed on the charcoal, which would be the case if the metal were lead, remove the bead to a small anvil and strike it with a hammer until flattened out (antimony and bismuth are brittle). The button boiled in a test tube with nitric acid does not dissolve, but is changed into a white insoluble powder. Antimony gives a similar reaction, but is brittle, and on charcoal would have burned, and given off thick white fumes of oxide of antimony. These tests will serve to distinguish tin from other metals which it resembles, but another still more characteristic test may be made as follows: reduce a bead of tin from the ore, by the method above described, hammer it out very thin, place it in a clean test tube and pour hydrochloric acid over it; action takes place and the metal dissolves. Before solution is complete (a portion of the metal remaining undissolved) pour a few drops of the solution into a vessel containing a dilute solution of terchloride of gold, a purple color will be produced which leaves no doubt that the metal is really tin. These tests are described with considerable attention to detail, because tin is liable to be found in quantity in California, and it is desirable to furnish the prospector with information by which he can test the ores he may find, supposed to contain tin. It is very important to concentrate a considerable quantity of the ore, as described, for experience has shown that tin may exist in small quantities in minerals and ores, not indicated by the appearance. Great care should be observed in the use of cyanide of potassium, which is a *deadly poison.*

Metallic tin is prepared by crushing the ores and concentrating the tin mineral (black tin), roasting to drive off arsenic, sulphur, etc., and fusion in contact with charcoal, or with a flux of lime. It is purified by fusion at a low temperature, at which the tin flows, leaving impurities behind. The impurities are arsenic, antimony, bismuth, zinc, titanium, and copper. Tin is obtained pure in the laboratory by oxidizing with excess of nitric acid, and washing the binoxide so obtained, first with water, and lastly with hydrochloric acid, and afterwards fusing in closed charcoal-lined crucibles. Tin so obtained is nearly chemically pure. The specific gravity of pure tin is 7.178. It is softer than gold, harder than lead, it crackles when bent, and has a peculiar odor when warm. It has but little ductility, but considerable malleability, which is increased when the temperature is raised to 220°. It fuses at 442° F. It is distinguished from other metals by the following properties and chemical reactions: It is *white, malleable, easily fusible*, is reduced to a white oxide by the action of nitric acid, and turns black in a solution of terchloride of gold, with excess of hydrochloric acid, without giving off gas.

THE ORES OF TIN.

The concentration of tin ores, to render them rich enough to smelt, is done by jigs, percussion tables, sluices, buddles, etc., all of which are described in works on metallurgy. Below are given the percentage yield of block tin, from celebrated Cornish mines, and the estimated value of the mines themselves:

Tincroft, $1\frac{3}{4}$ per cent block tin; value of mine, $2,100,000.
Dalcoth, $1\frac{3}{4}$ per cent block tin; value of mine, $1,790,000.
Cam Brea, $1\frac{1}{10}$ per cent block tin; value of mine, $1,280,000.

Some months ago application was made to the State Mining Bureau for the addresses of hydraulic miners competent to pipe the loose formations on the Malay peninsula for stream tin, the plan being to collect the tin as gold is collected by hydraulic washing.

Descriptions of the methods of mining and working of tin, manufacture of plate, etc., may be found in the following works, obtainable in San Francisco:

Metals; their Properties and Treatment. C. L. Bloxam.
Elements of Metallurgy. J. R. Phillips.
Percy's Metallurgy.
Encyclopedia of Chemistry. Lippincott.

USEFUL ALLOYS CONTAINING TIN.

Bronze—Copper and tin. Ancient bronze was largely copper.

Anti-friction metal, brass solder, or spelter, bronze for statues, imitation gold, button metal—Copper, zinc, and tin.

Britannia metal—Copper, antimony, zinc, and tin.

Metal for table bells—Copper, bismuth, and tin.

Speculum metal—Copper, arsenic, and tin.

Bronze for statues, bell metal—Copper, zinc, lead, and tin.
Imitation silver leaf—Zinc and tin.
Tin plate solder—Lead and tin.
Amalgam for mirrors—Mercury and tin.
Queen's metal—Lead, bismuth, antimony, and tin.
Pewter—Copper, antimony, bismuth, and tin.

One English firm requires one ton of tin per week for soldering. Tin foil, very extensively used in the arts, is generally adulterated with lead. The foil is said to be produced by preparing three sheets, one of lead and two of tin, the lead being the thickest. These are so laid that the lead plate is interleaved between those of tin. They are in this position rolled down to the thickness required, and the foil has the appearance of being tin, which it is, however, only superficially. No doubt serious trouble results at times from ignorance of this fact. At a recent meeting of the California Academy of Sciences, Dr. H. Gibbons called attention to the case of adulterated tin used in making cans for preserving fruits and vegetables, somewhat extensively manufactured in this city. The solder, also containing as it does considerable lead, should be used with caution.

Tin has been known and used from very early times. The bronze age which antedates history, succeeded the stone age, and was the commencement of the epoch of metals, the use of which followed probably in the following succession—gold, copper, tin, silver, iron. All these metals, except tin, are sometimes found in the metallic state, and from using the native metals, primitive man, without doubt, learned to reduce them from their ores. Bronze is an alloy of copper and tin in varied proportions. The alloy is better suited for universal use than either of the metals alone. The first bronze was possibly made by melting the ores of the two metals together in a charcoal fire, as we have reason to believe brass was first produced. Bronze is more fusible than copper, and makes clean castings. It is also harder than copper, and was a favorite material for the manufacture of articles of use and ornament. This alloy also has the property, probably well known to the ancients, of being, to a considerable extent, ductile when heated red hot and quenched suddenly in water. When hammered, it could be hardened by again heating and allowing it to cool slowly. It is said that the Chinese to this day make gongs and other bronze utensils by this method. It is thought by some archæologists, that all the tin used by the ancients was brought from Cornwall, which we know was the case when the Phœnicians were a great commercial nation; but bronze was used before the dawn of history in Europe, from which circumstance, a certain class of archæologists assume that ores of tin were more abundant in Central Europe, and were practically exhausted, like mines of gold, copper, lead, and other metals, celebrated in ancient history, by the drain upon them caused by the demand for the ores. It is supposed also that bronze was known, and in common use, long before pure tin and pure copper had been extracted from their ores. It is also probable, that about the commencement of European history, the ancient metallurgists and metal workers had learned to reduce the ores and make more constant mixtures by combining the two metals, as at the present time.

The Phœnicians made a great commerce of the metals which they imported from afar. Their ships sailed the Mediterranean Sea and out through the Pillars of Hercules (Straits of Gibraltar) into the

Atlantic Ocean. Thence they coasted northward along the coast of Portugal, Spain, and France, crossing the English Channel to the Cassiterides from which they obtained tin. Strabo mentions these islands. They were in the high seas, but nearly in the same latitude as Britain; these are now known as the Scilly Islands, off the coast of Cornwall. He quotes or rather refers to the writings of Posidonius: "The tin is not found on the surface, as authors commonly relate, but is dug up. It is produced both in places among the barbarians who dwell beyond the Lusitanians and in the islands Cassiterides; that from Britain is carried to Marseilles." The same author writes as follows:

The Cassiterides are ten in number and lie near each other in the ocean toward the north from the harbor of Artabri. One of them is desert, but the others are inhabited by men in black cloaks, clad in tunics reaching to the feet, girt about the breast and walking with staves, thus resembling the Furies we see in tragic representations. They subsist by their cattle, leading for the most part a wandering life. Of the metals they have tin and lead, which, with skins, they barter with the merchants for earthenware, salt, and brazen vessels. Formerly, the Phœnicians alone carried on this traffic from Gades (Cadiz) concealing the passage from every one; and when the Romans followed a certain shipmaster that they might find the market, the shipmaster of jealousy purposely ran his vessel on a shoal, leading those who followed him into the same destructive disaster. He himself escaped by means of a fragment of the ship and received from the State the value of the cargo he had lost. The Romans nevertheless by frequent efforts discovered the passage, and as soon as Publius Crassus passing over to them perceived that the metals were dug out at a little depth and that the men were peaceably disposed, he declared it to those who already wished to traffic in this sea for profit, although the passage was longer than that to Britain.

Tin is mentioned in the Bible several times and always in connection with other metals, gold, silver, iron, and lead, or in a metallurgical connection, with brass. In Numbers is mentioned tin with gold, silver, brass, iron, and lead. Isaiah 1–25, "I will turn my hand upon thee and surely purge away thy dross and take away all thy tin." Ezekiel 22–18, "They are brass, and tin, and iron, and lead in the midst of the furnace. They are even the dross of the silver." 20, "As they gather silver, and brass, and iron, and lead, and tin into the midst of the furnace, to blow fire upon it to melt it." Ezekiel 27–12, "Tarshish was thy merchant by reason of the multitude of all kinds of riches, with silver, iron, tin, and lead, they traded at thy fairs."

There are in the State Museum two objects in bronze, which possess a peculiar interest. They are both from the wreck of an ancient vessel, probably Japanese, of which there is no history. The old wreck lies outside the beach and beyond sight. The locality is the coast of Oregon, between the mouth of the Columbia River and Tillamook Bay. (1401) is a portion of a chain cable of hammered bronze; there are links and a portion of a swivel; the length of the links is 5 inches and the thickness of the metal is ¾ of an inch. (2228) is a bronze elephant washed ashore from the same wreck. The vessel was probably loaded with wax, portions of which have been washed ashore for many years. No. 2090 is a specimen of this wax found on the beach.

LOCALITIES.

Tin is comparatively a rare metal, being found at but few localities in the world. The principal countries which produce it now are Cornwall, England, Australia, Tasmania, the Islands of Banca and Billiton in the East Indies, and the Malay Peninsula. The metal is found also in small quantities at Ollenberg, Saxony; Zinwald, Bohemia; in France, Spain, Finland, Sweden, Greenland, Bolivia, Durango, Mexico; and in the United States in California, Dakota, Idaho, Alabama, Massachusetts at Chesterfield and Goshen, in New Hampshire at Lynne and Jackson, and in Virginia. As to the United States localities, the deposits of California, Dakota, and Alabama are the only ones which give promise of being valuable. The discoveries in the Black Hills, Dakota, are described as being very extensive, and if there is no mistake the supply from this locality is likely to be considerable. The tin deposits near Ashland, Clay County, Alabama, are known as the Broad Arrow mines. These mines are worked as open quarries, the ore here occurring both as lode and stream tin, all of low grade. The reduction works put up at these mines last Summer suspended operations after a few months run, and the success of the enterprise is involved in doubt. The mines of Banca were discovered by accident in 1710, and were first worked by the Chinese. In 1750 the yield was 3,870 tons. In 1817 the product was 2,083 tons, and in 1871, 4,320 tons. The ore, which is stream tin, is found from ten to fifteen feet below the surface; only a portion of the island has been prospected. Tin was found in Victoria, Australia, in 1853, by the Rev. W. B. Clark, a celebrated Australian geologist. It was afterwards discovered in New South Wales, in the New England Pastoral District, and still later in Queensland. Mr. J. Gregory reported to the Queensland Government that, having measured one hundred and seventy miles of creeks and river beds, he found on calculating the value as carefully as possible of the stream tin alone, without estimating the veins known to exist, that it amounted to the large sum of £13,000,000. The tin fields of Durango, Mexico, are known to be extensive, and it is likely that they will be washed when the systems of railroads now projected are completed. Tin has been found in at least three localities in California. In the Temescal Mountains, San Bernardino County, lies the only known deposit in the State, having a prospective value. In Plumas County, in the bed of the middle fork of Feather River, three miles above Big Bar, a single specimen was found by Mr. Thomas Lane of Laporte, and given to Professor W. P. Blake, and by him described as resembling the stream tin from Durango, Mexico. Another specimen was found some years ago near Weaverville, Trinity County, in the loose soil, and presented to Professor J. D. Whitney, then State Geologist. The vein from which it came was never found.

Grossularite, lime garnet, a common mineral in Southern California, resembles crystals of cassiterite, and has often been mistaken for it by Cornish miners. A number of reported tin discoveries have turned out to be this mineral. The Temescal tin mines are in the Temescal Mountains, whence the name. The mines are on Section 2, Township 4 south, Range 7 west, San Bernardino meridian; distant fifty-five miles east of Los Angeles, and thirty-five miles from Anaheim Landing. The ore was first supposed to contain silver, the presence of tin not being suspected.

The Temescal tin mines were discovered in 1853. Daniel Sexton and W. W. Jenkins were prospecting for gold, when they found ore that was new to them, but which they thought must contain some valuable metal, presumably silver. They brought the ore to San Gabriel Mission, and smelted it in a crucible with fluxes, in a blacksmith's forge. The contents of the crucible were poured out on the face of the anvil, when a piece of white metal (two inches long, and three quarters of an inch wide, thin at one end) appeared, which was, without doubt, the first piece of metallic tin produced in the State. Under the impression that it was silver, Mr. Jenkins took it to Los Angeles, and showed it to N. E. Drown and Major Henry Hancock, United States Surveyor, when it was found to be tin. They proposed to demand from the United States Government the reward supposed to have been offered for the discovery of a workable tin mine within the borders of the Union. Major Hancock endeavored to obtain a claim to the tin mine, which was found to be on the Temescal Rancho, supposed to be owned by Mrs. Josefa Montalva. Mr. Jenkins, at the request of Major Hancock, sent for her to come to Los Angeles, to execute a deed to the Major. When she arrived, she informed the Major that Don Abel Stearns and Requena were her good friends, and declined to convey. She afterwards disposed of her interest to Abel Stearns. In 1860–1 the locality was a scene of great excitement. Five hundred claims were located on the mineral belt.

A close corporation was formed, to which Mr. Stearns leased the property. Phelps, Dodge & Co., of New York, owned nine twentieths; S. C. Bruce, of California, eleven twentieths. Mr. Bruce commenced opening the mine September 27, 1860; erected buildings and sunk shafts ninety-five feet, when the civil war broke out, and all operations ceased till peace should be declared. The San Jacinto Tin Mining Company was organized January 2, 1868, with a capital stock of $4,000,000. The object of the company was to acquire Rancho Sobrante de San Jacinto, a Spanish grant of eleven leagues, or about 49,000 acres of land, supposed to cover the tin mines. The grant was confirmed, and a patent issued by the United States Government October 26, 1867. On the twenty-fourth day of June, 1868, the company took possession of the property, and on the twenty-seventh day of the same month and year work was resumed on the Cajalco mine, the same which was opened by Mr. Bruce in 1860. Mr. E. M. Robinson was Superintendent for the new company. Samples of the tin, tin plate with vessels made from it, and samples of the ore, were exhibited in the Mechanics' Institute Fair, at San Francisco, in 1869, winning for the company the Gold Medal. The bars of metallic tin then on exhibition are now in the Museum of the Pioneer Society. Of the ore there are fine specimens in the State Museum, represented by the catalogue numbers (134) and (235), the former from the Cajalco mine, and the latter from the San Jacinto mines. Specimens were shown at the Paris Exposition of 1878, and donated after the Exposition to the French Government, with many other California ores and minerals. They are now in the Ecole des Mines, in Paris.

The ores are very deceptive to the eye. No mineralogist, no matter how familiar he might be with other ores of tin, would recognize these by sight alone. They present a brown lusterless appearance, with spots of yellowish-brown. When concentrated by washing, the heavy powder which results may be readily distinguished by the microscope as cassiterite. The following is an analysis of the ore from these mines, by Professor F. A. Genth of the University of Pennsylvania:

Silicic acid	9.82
Tungstic acid	.22
Stannic acid	76.15
Oxide of copper	.27
Oxides of iron, manganese, magnesia lime, and alumina	13.54
	100.00

The stannic acid in the above analysis is equal to 59.92 per cent of metallic tin. The tin reduced from the ore yielded by analysis:

Metallic tin	99.78
Iron	11
Copper	11
	100.00

"The ores are found in mica slate, gneiss, and granite, and associated with iron, antimony, arsenic, and gold ores, in a gangue of quartz, fluor-spar, apatite, and baryta."—[Report of Company.] The Temescal River skirts the southwest boundary line of the property of the company, and the Santa Ana River flows but a few miles to the northwest; both streams furnish ample water-power for a portion of the year. Cornish miners and experts, and skilled mineralogists from various parts of the world, have examined these mines, and have pronounced favorably upon them. One who had large experience in the stannaries of Cornwall thought there was enough eight per cent ore in sight to make 600 tons of pig metal. Mr. William Williams, formerly employed in the mines, and whose statements appear in the reports of the company before referred to, told the State Mineralogist that it was a good mine and only required development to produce profitable returns. There are conflicting titles to these mines. The representatives of Abel Stearns are in litigation to recover possession. There is reason to hope that tin will become in the future one of the commercial products of the State.

PRODUCTION.

The world's production of tin in 1873 was estimated at 25,000 to 28,000 tons. In 1883 it was 45,770 tons. The product from 1878 to 1881, inclusive, is estimated at 147,553 tons. The United States uses more tin and tin plate than any other country, estimated at one third the world's production of this metal. It may be seen from this how important it is to develop any mines that we may have within our borders.

IMPORTS.

About 243,000 tons of tin plate are imported into the United States annually. In 1871 England exported 120,000 tons of tin plate, of which 67,140 tons were sent to the United States. From 1872 to 1882, inclusive, the United States imported of block tin 87,941 tons, valued at $41,293,644, and during the same time 1,500,329 tons of tin plate, valued at $159,035,810. The following is a table of Australian tin received at San Francisco:

Year.	Pounds.	Year.	Pounds.
1875	262,528	1880	764,060
1876	482,608	1881	1,495,088
1877	588,672	1882	1,834,320
1878	625,080	1883	1,298,209
1879	637,392		

Keeping pace with the growth of our canning industries, future requirements will increase year by year, the same being true all over the country. Among our most stringent wants are, therefore, largely productive tin mines. There is a widespread belief that at some time in the past the General Government has offered a large sum as a bonus to any person who should find a productive tin mine in the United States. The sum has been stated at from ten to two hundred thousand dollars. The Legislature of California has been reputed to have offered also a large sum for such a discovery. There is no truth whatever in such statements, although so generally believed.

CAT'S EYE—see Quartz.

28. CEMENT.

The mineral cements are nearly all artificial, and are made of lime and sand (mortar), calcined hydraulic limestones, or dolomites, to which certain ingredients are sometimes added. Pozzuolana (described under the head of building stones), plaster of Paris, concretes, etc., which will be found described under the various heads.

29. CERARGYRITE. Etym. "*Horn Silver*" (Greek).

This mineral is a chloride of silver (Ag. Cl). Composition as follows:

Chlorine	24.7
Silver	75.3
	100.0

Color pale yellow, gray, or green, nearly white. Luster resinous, appearance like wax; can be cut with the thumb nail, the cut having a shining luster. Sp. gr. 5.31 to 5.55. In closed tube melts, but is not decomposed. On ch. B.B. with carbonate of soda, a bead of silver is easily reduced. Another blowpipe test is made by melting a small portion of *pure* microcosmic salt in a loop of platinum wire, which is saturated with oxide of copper by dipping it into the vessel containing the oxide and again heating. If a small fragment is now added to the bead of prepared flux, and still again heated before the R. F., a distinct azure blue color will be imparted to the flame (chlorine). Cerargyrite is not soluble in nitric acid, but ammonia dissolves it wholly, and from the solution the chloride of silver is precipitated by neutralizing the ammonia with an acid. As cerargyrite is generally disseminated in the ore in such small particles, or crystals, as to be generally invisible to the unassisted eye, the latter plan is the best to detect it. The ore is first pulverized, and placed on a filter and leached with ammonia, which is then filtered and treated with the acid. If cerargyrite is wet with water slightly acidulated and laid on a piece of sheet zinc, it turns black and is soon reduced to metallic silver, which becomes bright and metallic if rubbed hard in an agate mortar. Cerargyrite is rather a common mineral in some of the southern counties of the State, associated with embolite, but seldom in masses sufficiently large to form good cabinet specimens. Microscopic crystals of great beauty are not uncommon, but the mineral generally occurs in very thin crusts. (4912) and (5158) are from

Slate Range, Inyo County. The finest microscopic crystals are found in the Modoc Chief mine, Inyo County. Cerargyrite is a valuable silver mineral, and is easily reduced by the most simple metallurgical process.

30. CERUSITE. Etym. *Cerussa* (Lat.). White Lead, Carbonate of Lead, White Lead Ore, etc. PbO, CO_2.

Carbonic acid	16.5
Oxide of lead	83.5
	100.0

Equivalent of metallic lead 77.5 per cent; color, white, gray, nearly black; transparent, sub-translucent to opaque; brittle, H=3--3.5; sp. gr. 6.46–6.48; B B on ch. fuses, and in the R. F. yields a bead of lead, coating the charcoal at the same time yellow. Dissolves in nitric acid, with effervescence. This mineral is very easily distinguished, and is rather common in California, seldom in crystals, but generally associated with galena, anglesite, azurite, chrysocolla, malachite, silver minerals, and gold. Fine crystallized specimens, with the associates above mentioned, are found in the Modoc mine, and in many other localities, in the Inyo and Coso Mountains, Inyo County; in the Russ district, in the same county, in large crystals resembling those from Siberia, and at Great Basin mine, near Mohave River (Blake). It is a valuable ore of lead, and in certain localities an indication of silver ores. A considerable proportion of the lead ores worked at the Cerro Gordo mines were cerusite. Thirty-two thousand tons of lead were produced in these mines during the time in which they were worked.

31. CERVANTITE. Etym. "*Cervantes*" (Span.). Antimony Ochre.

This is a rare mineral in California. It occurs with Stibnite in San Amedio Mountain, Kern County. (Blake.)

32. CHALCANTHITE. Etym. "*Flowers of Copper*" (Greek). Native Sulphate of Copper, Blue Vitriol.

This results from the decomposition of copper sulphide ores (see copper) and is rare in nature. At the Rio Tinto mine in Spain the waters contain so much of this mineral in solution that they are collected and the copper precipitated by iron, yielding cement copper in considerable quantities. It sometimes occurs in old copper mines in California when the waters do not flow from the workings, and old tools such as picks, gads, hammers, etc., left by accident in the old works, have been found changed to metallic copper, or to be very heavily coated with that metal. Specimens in the State Museum are from the Peck mine, Copper City, Shasta County, and from Sweetland, Nevada County.

The waters of a copper spring near Glenbrook, Lake County, deposit copper on a knife blade.

Chalcedony—see Quartz.

33. CHALCOPYRITE. Etym. "*Copper Pyrite*" (Greek). (See, also, Copper.) Copper Pyrites.

This mineral is a double sulphide of copper and iron:

Sulphur	34.9
Copper	34.6
Iron	30.5
	100.0

Color, brass yellow; opaque. Occurs both crystallized and amorphous; the latter generally mixed with other minerals. On ch. B.B. generally decrepitates, gives off fumes of sulphur, and fuses to a magnetic globule. If this is wet with hydrochloric acid, a blue color is imparted to the blowpipe flame; with fluxes, a bead of copper is obtained. The pulverized mineral dissolves in nitric acid, giving off red nitrous fumes; the solution is green, but if neutralized with ammonia becomes intensely blue. If the nitric solution is evaporated to dryness and redissolved in hydrochloric acid the whole of the copper will precipitate if a piece of iron or zinc is placed in the solution; the precipitation is accelerated by the application of heat. This mineral is quite abundant in California, being found in greater or less quantities from north to south. It is a valuable ore of copper, but its metallurgy presents so many difficulties that it is found generally more profitable to concentrate it and ship it to England than to work it here. Under some circumstances it has been found economical to reduce it to a matte by a single furnace operation, and ship it in that condition. It is also worked somewhat extensively at Campo Seco, Calaveras County, and at Spenceville, Nevada County. The following California localities are represented in the State Museum: (3017.) Campo Seco, Calaveras County. (4119.) Beveridge District, Inyo County. (4137.) Lexington, Santa Clara County. (4247.) San Diego County (in steatite). (4274.) Stony Creek, Colusa County. (4387.) Spenceville, Nevada County. (4485.) Bullion District, Plumas County.

Chalcopyrite is common in ores containing gold, all over the State. It occurs with erubescite and pyrite at Copper City, Shasta County; at Copperopolis and Lancha Plana, Calaveras County; in specks in the jaspers in San Francisco County; Light's Cañon, Plumas County (Blake); near Hornitos, Mariposa County; in the rocks of Mt. Diablo (Blake); in Los Angeles, San Bernardino, and San Diego Counties; the Inyo and Coast Range Mountains; in fact, it is almost universal in its distribution over the State.

34. CHALCOSITE. Etym. *Copper* (Greek). Vitreous Copper, Copper Glance.

This mineral is a sulphide of copper (Cu_2, S).

Sulphur	20.2
Copper	79.8
	100.0

Color, dark lead-gray, often green on the surface. Luster metallic, H.=2.5—3.0. Sp. gr.=5.5—5.8. B.B. on ch. melts and gives off fumes of sulphurous acid, and with fluxes is easily reduced to a bead of copper. Soluble in nitric acid; the solution gives similar reactions to those described under the head of Chalcopyrite. It is found with other ores of copper in the State, more frequently in the southern counties. It is sometimes argentiferous, and merges into Stromeyrite, which see. It occurs in the silver ores in Inyo and San Bernardino Counties; in Genesee Valley (in basalt), Plumas County (Edman); in San Diego County; in Los Angeles County; at the Maris mine, in grains and irregular masses, in syenitic granite, containing silver (Blake); and in San Luis Obispo County. No. (4486) is from the Enterprise mine, Bullion District, Plumas County.

CHESSY COPPER—see Azurite.

CHLORIDE OF SILVER—see Cerargyrite and Embolite.

CHLORO-BROMIDE OF SILVER—see Embolite.

CHLORO-CARBONATE OF LEAD—see Phosgenite.

CHROME IRON—see Chromite.

35. CHROMITE—Etym. "*Color*" (Greek). Chromic Iron, Chrome Ore, etc.

Chromic iron is the ore from which all the salts of chromium are obtained. It is a dense, heavy, dark colored mineral, which is usually compact, although sometimes granular. Its sp. gr. is from 4.34 to 4.498. It is hard enough to scratch glass. Its streak and powder are brown, even if the mineral is black. Before the blowpipe it is infusible alone, but with borax it slowly melts, forming a characteristic green glass. It occurs in serpentine rocks in irregular masses, rarely in veins. Serpentine and several varieties of marble, especially "verde antique," owe their beautiful green color to the oxide of chromium. The emerald is also indebted to this mineral for its charming color. Chromic iron is seldom found pure. When crystallized its composition is expressed by the formula, $FeO\ Cr_2\ O_3$. The mean of ten analyses of samples from different localities was found to be·

Protoxide of iron	27.53
Magnesia	6.50
Alumina	9.57
Sesquioxide of chromium	53.62
Silica and loss	2.78
	100.00

The metal chromium was discovered by Vanquelin in the year 1797. As early as 1766 Lehmann wrote a letter to Buffon giving a description of a new mineral of a bright scarlet color which was found in a mine in Siberia. Pallas, the celebrated naturalist, believed it to be a compound of lead, arsenic, and sulphur. The most celebrated chemists of the period attempted to analyze it, but the results obtained differed so widely that much was said and written upon the subject. In 1797 Vanquelin made a critical examination of it, and found it to be oxide of lead, combined with an acid having a metallic base which was new to science. He afterwards succeeded in reducing the metal and produced *chromium*, so named from the Greek word signifying color. The red mineral which led to this discovery was chromate of lead, now known by the name of "Crocoisite."

Metallic chromium may be reduced from the oxide by subjecting it with charcoal to an intense heat. It is a metal possessing a color between that of tin and steel. Its specific gravity is 5.9. It is nearly infusible, does not oxidize in the air, is not magnetic, or only slightly so; and very brittle. It is scarcely acted on by nitric, hydrochloric, or nitro-hydrochloric acids, but dissolves in hydrofluoric acid with evolution of hydrogen. Chromium is also reduced by galvanic electricity; by adding sodium amalgam to a solution of chloride of chromium an amalgam of chromium is produced which is distilled, leaving the metal in a pulverulent state; and by heating the oxide in a porcelain tube in an atmosphere of hydrogen into which vapors of sodium are admitted. The reduced metal is found to be in the form of crystals. The metal fuses with great difficulty, and is non-volatile. In the metallic state no use has yet been found for it in the arts.

CHIEF USE OF CHROME ORES.

The chief use of chrome ores is the production of the beautiful salts known in commerce as the chromate and bi-chromate of potash, which are used principally in dyeing and in the manufacture of pigments. Treated in a large way, the ore is crushed under heavy edge-wheels, and then bolted. It is essential to the success of the operation that the minutest division is effected. The pulverized ore is then mixed with half its weight of nitrate of potash, and subjected to a high heat for several hours on a common reverberatory hearth. During the process the mass is occasionally stirred. When the proper time has arrived, the whole is raked out and a fresh charge introduced. The fused mass is allowed to cool, and is then lixiviated with water. The yellow solution is concentrated by evaporation and allowed to crystallize. The resulting salt is "chromate of potash." To obtain the bi-chromate, which is most used in the arts, the concentrated solution is treated with a strong acid—either nitric, hydrochloric, or acetic. The acid combines with the second atom of potash, leaving the bi-chromate in solution, which may be crystallized out in the usual manner.

These salts are extensively used in dyeing. To dye yellow, the material is first passed through a solution of acetate or nitrate of lead, and then through one of bi-chromate of potash, by which chromate of lead is formed, which is yellow. If it is desired to dye a fabric *green*, it is first dyed blue, and then yellow as above, by which combination green results.

Orange is produced by dyeing yellow, and then passing the material through a boiling solution of caustic lime, by which the orange sub-chromate of lead is formed. Bi-chromate of potash is also used to give a brown color, by being used with catechu, by which a great variety of brown, drab, and fawn colors are produced. This salt is used in the manufacture of ink. There are said to be six chemical works in which bi-chromate of potash is produced—three in Glasgow, Scotland, and one each in Russia, Austria, and the United States.

Bichromate of Lime.—Finely powdered chrome iron is intimately incorporated with chalk. This mixture is exposed in a layer one and a half inches thick for ten hours in a reverberatory furnace. The product is chromate of lime, difficultly soluble by grinding while suspended in water with a slight excess of SO_3. To separate any protosulphate of iron present, milk of lime is added; the clear layer consists of bi-chromate of lime in solution.

There is a specimen of Aragonite in the State Museum No. (3602) that might be used as a substitute for chalk.

Chromic Acid ($Cr\ O_3$) forms prismatic crystals of a dark ruby red color, which are deliquescent and color the skin yellow. When it is heated to redness, or parts with one equivalent of oxygen, it becomes the green protoxide. When its solution is neutralized with ammonia it is changed into the sesquioxide with energetic chemical action. It dissolves in alcohol, from which crystals of the green oxide gradually deposit. The aqueous solution of chromic acid is decomposed by the sun's rays, oxide of chromium being precipitated. If chromic acid, obtained by decomposing chromate of baryta with sulphuric acid, or four parts of chromate of lead, is mixed with three parts of finely powdered pure fluorspar freshly calcined, and five parts of concentrated sulphuric acid, placed in a still of platinum, or lead, and gently heated, a red vapor passes over which is condensed into distilled water contained in a vessel of platinum, and a dark orange colored liquid results. The vapor (fluoride of chromium) decomposes in the water to hydrofluoric and chromic acids. The liquid evaporated in the platinum dish becomes pure chromic acid. Chromic acid is generally made by mixing a solution of bichromate of potash with a large quantity of strong sulphuric acid; as the mixture cools, crimson red crystals of chromic acid form; these are washed with strong nitric acid and dried. The proportions used are 100 volumes of cold saturated solution of bichromate of potash and 150 volumes of strong sulphuric acid. The acid must be added in small successive portions. Chromic acid forms salts with numerous bases. The resulting chromates are all red or yellow, and are usually soluble in water.

Sesquioxide of Chromium ($Cr_2\ O_3$) is obtained by igniting chromate of mercury, or by calcining a mixture of equal parts of flour sulphur and pulverized bichromate of potash in a closed earthern crucible, and washing the green residue with hot water to remove the sulphate of potash. The thoroughly washed residue is dried at a water-bath heat. After exposure to a red heat it resists the action of acids. It is converted into chromic acid by deflagation with nitrate of potash.

Hydrated Oxide of Chromium is precipitated from acid solutions by alkalies in the form of a voluminous green powder. It may be obtained by adding a mixture of equal parts of alcohol and hydrochloric acid portionwise, to a boiling solution of chromate of potassa; the liquid becomes pure green in color. When cold, an excess of ammonia is added, which precipitates the hydrated oxide, in which state it is soluble in acids.

It may also be prepared as follows: Mix chromate of potassa with half its weight of chloride of ammonium; heat the mixture to redness, and wash the resulting mass with excess of boiling water.

Oxide of Chromium is used in the arts as a pigment—in glass staining, in painting on porcelain, and in producing artificial gems. It is also now extensively used in printing United States currency—"greenbacks." It is a lively green-colored powder. It is so expensive that it cannot be generally used, although it is the only permanent green pigment known to the chemist. An artificial gem, almost equal to the emerald, is made by fusing together: Fused boracic acid, 4.06 parts; silica, 7; alumina, 1.60; glucina, 1.40; oxide of chromium, 0.10.

A beautiful green aventurine glass has been made by M. Pelouze, composed as follows:

Sand	250 parts
Carbonate of soda	100 parts
Carbonate of lime	50 parts
Bichromate of potassa	40 parts

This glass melts with difficulty. It is described as being of "a deep green color, and full of small spangles—crystals of oxide of chromium—which sparkle with a brilliancy inferior only to the diamond." Chromic iron has within a few years been put to a new use. It is now melted with ordinary iron, forming an alloy of iron and chromium, which is harder than iron, and has a kindred use as a substitute for steel in certain cases. The following is translated from a French pamphlet, published in Paris, in 1878:

REMARKS ON CHROME STEEL.

By M. G. Rolland, Mining Engineer.

Products known of late years in metallurgy as chrome steel have excited a great interest; they are extremely hard, and remarkably resistant to traction. These species of steel contain a few tenths per cent of chrome. The chrome has the property of greatly increasing the hardness and resistance of the metal, but it has no tempering properties, and could not, as it is sometimes said, take the place of carbon and replace it. Mr. Boussingault melted a mixture of iron, of four per cent of carbon and oxide of chrome combined, in such proportions that the oxygen of the former would exactly consume the carbon of the latter; the residue obtained was an alloy of non-carbureted iron and chrome, which could not be tempered.

Berthier is the real inventor of chrome steel. As early as 1821 he was conversant with the way of "introducing chrome into cast-steel," and said that "steel alloyed with chrome possessed properties which could make it very useful in many instances."

I quote the following extracts from Berthier's works on "Combinations of chrome with iron and steel," published in 1821, in the "Annales des Mines," first series, vol. 6, page 573, and the "Annales de Chimie et de Physique," second series, vol. 17, page 55:

"To prepare with an ore of the nature of that of the Island of the Vaches (chrome iron, containing 0.370 of peroxide of iron, 0.360 of oxide of chrome, 0.215 of alumina, 0.050 of silica), which is a mixture very rich in chrome, it is necessary to melt this ore in a crucible of damp charcoal, with 0.30 of lime and 0.70 of silica, or with 1.00 of vitrified borax; and to extract the greatest quantity possible of chrome from this ore, it will be necessary to add a certain quantity of oxide of iron to the flux. It is evident that the quantity of flux employed will vary with the quantity of alumina contained in the ore, and that the smallest quantity of it must always be used—borax by economy and to decrease volatilization, and glass or silica flux because it stops the reduction of the oxides which are combined with them. The Philadelphia ore (chrome iron containing 0.372 of peroxide of iron, 0.516 of oxide of chrome, 0.097 of alumina, 0.026 of silica) would easily melt with 0.14 of lime and 0.32 of silica; or with 0.50 of alkaline glass, or also with 0.16 to 0.20 of vitrified borax, it would give a much larger proportion of alloy than that of the Island des Vaches, and this alloy would contain much more chrome."

If I have given extensive explanations on the manner of preparing economically alloys of iron and chrome, it is not because I think that these alloys can of themselves be of great use, but because it is probable that they will be used to introduce chrome into cast-steel. The idea of introducing chrome into cast-steel was suggested to me by the lecture on Mr. Faraday's works on "Alloys of Different Metals With Steel." I found that steel, combined with chrome, had properties which could make it useful in many instances.

I made two alloys of cast-steel and chrome, one containing 0.01 of chrome and the other 0.015. I prepared the "chrome steel" by melting best cast-steel, pounded into small pieces, with an alloy of iron and chrome. This is the way to proceed when manufactured in large quantities.

Chrome steel is manufactured at this time to my knowledge in the United States at Brooklyn, New York (Chrome Steel Company), in England at Sheffield, and in France at Unieux, Loire (Holtzer Steel Company).

Having visited in 1876 the Brooklyn foundry, I will briefly state the mode of manufacture and qualities of its products. This pamphlet contains not only the information obtained by me in America, but also the analysis and information of Mr. Boussingault, who kindly helped me in this work by his valuable information.

Mr. Boussingault will shortly publish an account on chrome iron and chrome steel, and on the different processes of dosing the chrome.

The manufacture of chrome steel in Brooklyn, though it is kept very quiet, is only an application of Berthier's process. The chrome iron ores used in that foundry come from Baltimore, and have varied as to their composition; some contained 13 per cent of alumina, and 11 per cent of silica; others as much as 60 per cent of oxide of chrome and no silica. The ore, pulverized and mixed with pulverized charcoal and a suitable flux, is reduced in graphite crucibles; the production is a white chrome iron, similar to Berthier's alloy of iron and chrome. It is called "Ferro-chrome," by analogy with the "Ferro-manganese." Ferro-chrome of Brooklyn, analyzed by Mr. Boussingault, indicated 4.25 per cent of combined carbon, and 48.70 per cent of chrome.

The Ferro-chrome from Unieux contains about 5.4 per cent of combined carbon, and as much as 67.2 per cent of chrome.

Chrome is accidentally found in certain iron smeltings. A few tenths per cent have been found in iron smeltings in Russia. Mr. Boussingault found 1.95 per cent or more of it in the white iron smeltings of Medellin, Province of Antioquia, South America, which are remarkable for their hardness.

Chrome steel is obtained afterwards by melting in a crucible (in a Siemens furnace of 24 or 32 crucibles) fragments of best iron or steel from America, Sweden, or Norway, with an addition of ferro-chrome, calculated according to the desirable degree of temper or hardness. Mr. Boussingault found, in a piece of hard steel manufactured in Brooklyn, 1.10 per cent of combined carbon, and 0.44 per cent of chrome.

The chrome steel from Unieux is manufactured in a similar way as that of Brooklyn. The quantities of chrome vary between 0.5 per cent and 0.9 per cent; the proportions of silicon and manganese could be easily omitted.

The Chrome Steel Company manufactures three principal qualities of chrome steel. No. 1 is the hardest, and is used for tools, drills, and planing machines for working hard substances, such as the shell-off of cast iron; No. 2 is used for tap-borers, punches, and jewelers' rollers; No. 3, called the universal number, for scissors, drills, and all sorts of tools to cut substances of medium hardness. There is also a No. 1 extra hard, for choice tools; and a No. A, softer than the No. 3 (which does not temper), and preferable for certain other tools, such as hammers of superior quality, gun barrels, etc.

At Unieux very hard chrome steel is mostly manufactured; this is used for choice tools; they have also tried to manufacture there pieces of artillery tubes of chrome steel, containing 0.6 to 0.7 per cent of combined carbon, and about 0.58 per cent of chrome.

When tapped chrome steel is generally less liquid than ordinary steel. The unwrought bar when hot, or after being heated again, is first roughed down with a stamp hammer, heated again and then brought down to the desired shape or size by hammering or rolling.

The bars or manufactured articles are always small in size. It seems that large pieces of chrome steel are not easily worked, probably because they are less homogeneous after cooling.

According to Mr. Julius Baur, chrome steel does not deteriorate when submitted to a high temperature (except a superficial oxidation); at Brooklyn the metal is boldly heated to the highest temperature before it is worked, except for punching, which is done at a medium heat. Mr. Julius Bauer says, also, that chrome steel is more easily welded, either to itself or to iron, than common steel.

On the contrary, Mr. Ridley having puddled common gray iron smeltings with an addition of chrome smeltings, found that the chrome smeltings increased the length of the puddlage, and that whatsoever was the quantity added, the oxide of chrome that resulted made the scoria thicker and the welding of the iron more difficult. There was a little chrome left in the wrought iron, but its influence, either good or bad, was worth little notice.

At Brooklyn the Nos. 2 and 3 are prepared for welding purposes.

Chrome steel is particularly hard to temper, and for that reason must be heated at the lowest possible temperature to the cherry red color, which is sufficient for it to be tempered. It is necessary to let it cool after it has been hammered, and heat again before tempering all tools coming from pieces relatively large and having thin edges, because, if the tool was plunged into water, or any other cold bath, the inside of the piece which cools slower than the outside would be tempered too hot, and would be apt to crack.

The following is a simple way of ascertaining the temperature at which it is proper to temper chrome steel. The end of a bar is placed in a furnace and heated; it is after removed, and the different degrees of heat are taken on several parts of the heated portion, and then plunged into cold water. After cooling, the bar is broken into small pieces by striking it on an anvil. If the end of the bar was too hot, the grain of breakage will be at first coarse, but will gradually decrease at the spot where the heat of the bar was of a dark red color; the grain will then become finer and more fibrous, the steel being harder, stronger, and less brittle than in the spots which had been more heated. The spot where the steel shows a fine and fibrous grain was at the suitable temperature.

The Chrome-Steel Company claims exceptional qualities for its steel. Cold, its tractive power would be greater than any other steel; tempered, it could not be drilled by any other steel, and would perforate any other steel containing an equal quantity of carbon. Experiments have been made at the West Point foundry on the tractive power of American steel containing chrome manufactured at Brooklyn; they were of different degrees of hardness—some hot, others cold (specific gravity 7.8161 to 7.8536), maximum charge of rupture 139 kilogrammes 84 hundredths per square millimetre; minimum charge 115 kilogrammes 13 hundredths.

The greatest tension of rupture of steel bars given by the metallurgical works of Percy, is of 107 kilogrammes per square millimetre at the section of rupture. (Cast-steel for tools of Torton.)

The Chrome-Steel Company made a very interesting exhibit at the Philadelphia Centennial

Exposition. It consisted of chrome ore, ferro-chrome, chrome-steel in bars and in tools of different shapes and sizes, bars twisted and bent when cold, etc.; also steel plates for safes, etc., in sheets of chrome steel and iron welded together and tempered (chrome steel cannot be perforated by ordinary tools—the iron remains ductile and does not break with a blow), safety bars for prisons, banking houses, etc.; also manufactured with chrome steel and iron welded together and tempered, they can neither be sawed nor broken; beams of chrome steel and iron of all shapes welded together. This combination adds to the strength and reduces the weight.

Many parts of the large metallic bridge on the Mississippi River, at St. Louis, are of chrome steel; but in this case I do not think that the use of chrome steel was necessary.

Before ending, I must say that in America, as well as in Europe, chrome steel is generally not much known, and has had, up to this time, more detractors than partisans. It certainly has many great qualities which make it very useful in many special cases, and which will keep it from disappearing; but its application is too limited for it to be manufactured on a large scale.

According to Mr. Sergius Kern, of St. Petersburg, a new process of chrome steel manufacture has been tried at the Oubouchoff steel foundry, in Russia. The process consists in melting in refractory clay crucibles a mixture of pounded Bessemer or Siemens-Martin steel and iron, or refined iron smeltings, according to the degree of steelness wanted, in subordination of an addition of chrome iron and limestone, roasted and pounded beforehand (these placed in the bottom of the crucible). Mr. Kern does not say if the new process has in view the introduction of chrome in steel; he only insists on the two following points:

1. Benefit of employing chrome iron instead of ferro-manganese, frequently used in our days as a reducer; but the price of ferro-manganese is high, and it makes the steel phosphorous and sulphurous.

2. Benefit in using Bessemer's and Siemens-Martin's steels, which are manufactured at present at little cost and with great care, instead of steel bars puddled with wood, which are always expensive, and are never uniform as to their amount of carbon. In these experiments a lot of cast-steel was manufactured, in which the amount of combined carbon varied from 0.20 to 1.30 per cent, and the amount of chrome from 1.01 to 0.25 per cent. These sorts of steel have been classified in four numbers. The average amounts of carbon are: 0.25, 0.49, 0.95, and 1.20 per cent. Experiments on tractive power were made on bars hammered first and hammered after; the average weights of rupture, resulting from six experiments for each number, are for: No. 1, of 75 kilogrammes, 75 hundredths for each square millimetre; No. 2, of 77 kilogrammes, 49 hundredths for each square millimetre; No. 3, of 82 kilogrammes, 37 hundredths for each square millimetre; No. 4, of 86 kilogrammes, 15 hundredths for each square millimetre.

The salts of chromium, as before mentioned, are extensively used in dyeing and in the manufacture of pigments.

Chrome yellow, or chromate of lead, occurs in nature as red lead ore or crocoisite, but has not been found in California. The pigment, under the same name, is prepared artificially on a very large scale.

There are two varieties of chrome yellow, named technically, "lemon" and "orange." They are prepared as follows:

The lemon chrome is known under the various names of Paris, Leipzig, Gotha, Hamburg, Cologne, Imperial, Citron, and New Yellows; but they are all prepared in a similar manner, with certain minor differences.

This beautiful color is made by adding a solution of chromate of potassa to one of nitrate or acetate of lead, and washing and drying the precipitate on a filter. Light lemon chrome is made by adding sulphuric acid or solution of alum to the chromate solution, before pouring it into the solution of lead. Bichromate makes a deeper shade of yellow.

The following formulæ are modifications of the above:

Twelve and one half pounds of bichromate of potash dissolved in twenty-eight and one half gallons of water, precipitated with solution of nitrate of lead, yields fifteen and one half pounds of chrome yellow. In theory fifteen pounds bichromate of potassa, and nineteen pounds acetate of lead, yield twenty-one pounds chromate of lead—but these results are not obtained in practice.

In making canary yellow, using the same solutions, care is taken to pour the nitrate of lead solution into that of the chromate, and never the reverse.

Sulphur Yellow.—Five pounds chromate of potash dissolved in two hundred pounds of water, add eight pounds sulphuric acid 66° B., and pour in solution of nitrate or acetate of lead as long as a precipitate falls.

The following recipe is given for making chrome yellow from sulphate of lead:

Mix 100 pounds of litharge with 10 pounds common salt and add warm water sufficient to make a paste. In twenty-four hours the mixture begins to rise; stir well, and should it have thickened by the operation, add water sufficient to reduce it to its former consistency. Repeat daily until the operation is finished, which is known by whitening of product. At a temperature of 20° to 24° C. the operation completes itself in 45 days; when all is changed to chloride of lead, add 12 pounds of nitric acid. Stir well and leave it a few hours, and add a saturated solution holding 15 pounds of alum. Stir well once more, chloride of lead is thus changed to sulphate. After several hours add the sulphate of lead, without removing the mother liquors, to a solution of bichromate of potash, 1 pound of the salt to 15 pounds water. If a light shade is required, pour chromate solution, when cold, in a thin stream, stirring well. To make orange *hot* solutions are necessary. An orange shade is produced by substituting carbonate of soda for the alum. Subchromate of lead, orange chrome, is made by pouring together solutions of bichromate of potash and subacetate of lead. Subacetate of lead is made by boiling litharge and solution of acetate of lead together. The following recipe gives a deep chrome red or orange almost equal to vermilion by actual experiment: 4 pounds dry white lead, 1 pound bichromate of potash, 20 pounds water (or larger quantities in the same proportion); boil together until the solution is colorless. The liquid is drawn off and the pulp well mixed—best by grinding in a paint mill.

Theoretical reactions in the production of chromates of lead from carbonate of lead.

Chromate of Lead.—$2\,(PbO, CO_2)\ (267.14) + (KO, 2\,CrO_3)\ (148.51) = 2\,(PbO, CrO_3)\ (324.54) + KO\ (47.11) + 2\,(CO_2)\ (44).$

Sub-Chromate of Lead.—$4\,(PbO, CO_2)\ (534.28) + KO, 2CrO_3\ (148.51) = 2\,(2PbO, CrO_3)\ (547.68) + KO\ (47.11) + CO_2\ (88.)$

Orange chrome, when well prepared, is a dense beautiful pigment, which is obtained of various shades, from light orange to the deepest red, by modifying the solutions. It has remarkable staining properties; that is to say, it imparts its color to a large quantity of white lead or other paint. It covers well, but is subject to the same changes from foul gases and sunlight, which make all lead pigments objectionable. Sulphuretted hydrogen, which forms a part of sewer gases, common illuminating gas, and bilge water, turn it black (sulphide of lead), but with all these objections it is extensively used and could hardly be dispensed with by the painters. The light chrome yellows are rather difficult to produce as the solutions are apt to become basic. This may in part be avoided by leaving the precipitate for some time in a dark place. The yellow pigments are often adulterated, sometimes as much as 50 per cent; generally with whiting, but often with sulphate of lead, white lead, clay, sulphate of baryta, ochre, gypsum, oxide of zinc, etc. These factitious materials are stirred in while the precipitations are being made. Pure chromate and sub-chromate of lead are perfectly soluble in nitric acid *without effervescence.* Sulphates of lime, lead, and baryta remain undissolved. It is also soluble in potassa. It gives a green solution with HCl, leaving a white residue of chloride of lead, soluble in excess of water. With caustic soda becomes orange on boiling and forms a yellow fluid with no residue if pure. On ignition becomes reddish brown; gives beads of lead with soda on charcoal. It is poisonous. A good method of testing the chromate it contains is to make a lead crucible assay and to calculate the percentage of lead that ought to be present in the pure pigment.

Light chrome yellow may be changed to orange by digesting it with solution of bichromate of potash.

Chromate of zinc and chromate of baryta are sometimes used as pigments. They have the advantage of not being affected by fumes of sulphuretted hydrogen, but they are deficient in body. The former is made by precipitating a boiling solution of sulphate of zinc, with one of chromate or bichromate of potassa; and the latter by substituting chloride of barium in the cold.

Chrome Red, or American Vermilion, is a beautiful scarlet pigment, made by the following recipe:

Melt saltpeter (nitrate of potash) in a crucible to dull redness, and add pure chrome yellow by small portions until no more red fumes arise. Allow the mixture to settle, then pour off the fused salt from the heavy residue. Wash the latter with water, which should be quickly poured off, and dry the pigment. The liquified salt poured off contains chromate of potash, and is reserved for making chrome yellow. When well made this is a beautiful pigment, but has all the faults of other preparations of lead.

Chrome Green—called also Oil Green, Green Cinnabar, Naples Green, etc. The chrome green of commerce is a mechanical mixture of chrome yellow and Prussian blue; the shades are made by varying the proportions. The true chrome green is the sesquioxide of chromium. Oxide of chromium, as an ordinary pigment, is deficient in brilliancy, but is considered permanent. It is chiefly used as a coloring on porcelain and fine pottery, it being one of the few colors which remain unchanged when submitted to great heat. It gives color to marbles, verd antique, serpentines, jasper, beryl, and other minerals, as mentioned before.

The following formula is given for the production of green cinnabar: Prussian blue is dissolved in oxalic acid, chromate of potassa is added, which is precipitated with solution of acetate of lead. The precipitate is thoroughly washed with water and dried. It is a beautiful green pigment; by varying the solutions different shades are obtained. The telegraph company of San Francisco use six ounces of bichromate of potash in each battery cup, and there are 3,000 or more in the City of San Francisco alone. The batteries are renewed every three months; all the solutions are thrown away and wasted. The chromic oxide could easily be recovered. Chromate and bichromate of potash are used as reagents in chemical analyses to detect the presence of lead, baryta, and mercury. These salts are also used in tanning leather.

DETERMINATION AND ASSAY OF ORES AND MINERALS CONTAINING CHROMIUM.

Chromic iron is valued for the percentage of the sesquioxide of chromium it contains. The assay is simple. Chromic iron is, however, extremely difficult to wholly decompose, which must be effected before a perfect assay or analysis can be made.

The following method is given by Fresenius: The ore must first be extremely finely divided by triturating in small portions in an agate mortar, or in a large way by bolting. For the assay, fuse eight parts, by weight, of borax in a platinum crucible; add to the mass while in fusion one part of the pulverized ore, and keep the crucible for half an hour at a bright-red heat; add dry carbonate of soda as long as it causes effervescence. Then gradually, and with frequent stirring with a platinum wire, add three parts of a mixture of equal parts of nitrate of potash and carbonate of soda, and keep the mass for a few minutes in fusion. When cold, dissolve in distilled water with heat, and filter. The residue which remains on the filter must wholly dissolve in hydrochloric acid, or the decomposition has not been successful, and the operation must be repeated with more care. The chromic acid, in the yellow aqueous solution, is thrown down by a solution of nitrate of mercury and the precipitated chromate of mercury, well washed and dried. When calcined, the volatile mercury is driven off, leaving pure sesquioxide of chromium, which is weighed and the percentage calculated. Sometimes the solution from the crucible is precipitated by acetate of lead, and the oxide of chromium calculated from the weight of the chromate of lead. It will be necessary in that case to nearly neutralize the solution with acetic acid before adding the acetate of lead. The calculation is made as follows: Suppose one gram of the ore was used in making the assay, and the sesquioxide of chromium obtained by the first method was 0.436. This multiplied by 100 would give the percentage=43.6. In the latter case it would be as follows, using the same figures: One part of neutral chromate of lead contains .3096 parts of chromic acid, and 43.6 of chromate of lead obtained would equal $43.6 \times .3096 = 13.498$, the percentage of chromic acid in the ore. To obtain the sesquioxide equivalent calculate as follows: One part of chromic acid contains .5200 of chromium, and one part of the sesquioxide .6842 parts of chromium, $\frac{6842}{5200} = 1.315+$. Then one part of chromium, obtained by the above calculation, would be equivalent to 1.3154 parts of the sesquioxide. To simply test for the presence of chromium in a mineral, the following will afford quick and reliable results: The ore is finely powdered in an agate mortar. A bead of borax is then formed in a loop, on the end of a platinum wire, by heating the loop by means of a blowpipe flame. While still red-hot, the end of the wire is touched to some powdered borax and again heated. This is repeated until a transparent bead of borax glass incases the loop. When cold, the bead should be colorless, if the wire was clean and the borax pure. The bead is then to be slightly wetted and touched to the powdered ore. Only a small portion should be allowed to attach itself to the bead. The blowpipe flame is again applied until the substance is perfectly fused with the borax. While hot, the bead will generally be of a faint yellowish color, but when cold, if chromium is present, it will become emerald green. If the bead is touched while hot with a piece of tin-foil, the reaction will be intensified. It sometimes happens that too much of the powder attaches itself to the bead and an opaque glass results. In this case the bead may be broken by a blow from a small hammer, and the powder placed on a piece of white paper, when the characteristic green color will be seen. This color must not be confounded with the bottle-green, which results from iron treated in the same manner.

To make this assay still more certain, proceed as follows: Saturate the borax bead as directed, using more of the mineral without regard to the color—dip the bead into pulverized nitrate of potash, and heat again strongly in the blowpipe flame. The bead will now be yellow and opaque. Repeat the operation as long as the flux can be made to remain on the platinum loop. Let it cool and detach by a blow from a small hammer. Grind the powder in an agate mortar with water until a solution is formed. Add a drop or two of acetate of lead, using a glass rod for this purpose. A yellow opaque precipitate will appear. Now transfer the liquid and precipitate to a small white paper filter, and dry. It will be easy now to recognize, under a microscope, chrome yellow on the paper. This is a very conclusive test, and can easily be made in twenty minutes.

LOCALITIES OF CHROME ORES.

Chrome iron is found in Russia, Norway, Shetland, France, Silesia, Bohemia, Styria, Asia Minor, Australia, New Zealand, New Caledonia, and in numerous localities in the United States other than California; but only in considerable quantities in the Bare Hills, near Baltimore. The wants of the world are estimated at 2,000 tons annually.

FOREIGN LOCALITIES.

J. Lawrence Smith visited Asia Minor in 1848 and discovered a deposit of chromic iron, fifty miles from the City of Broussa. He concluded that the serpentine contained the elements of the chromic iron, which may separate by force of aggregation from the rock mass. He found, also, magnesite, in which there were visible small specks of chrome iron.

Chrome iron is largely mined in Russia. The deposits lie in Perm, Orenbourg, and Oufa. The following table gives the production in "pouds," one poud equals thirty-six pounds, or nearly 526.64 ounces Troy.

PRODUCTION OF CHROME IRON IN RUSSIA.

[OFFICIAL REPORT.]

Year.	Number of Mines.	Quantity of Chrome Iron obtained, in "pouds."
1867	2	86.877
1868	5	41.084
1869	2	66.831
1870	9	600.024
1871	6	450.973
1872	7	372.549
1873	9	391.809
1874	6	316.561
1875	8	209.848
1876	4	58.167

At the chemical works in Russia, in which bichromate of potassa is prepared, the workmen are troubled with a disease peculiar to the business. The following description is taken from a technical paper:

The manager of the single establishment in Russia for the manufacture of chrome reports a curious disease among his men. He says: "The workmen suffer from the action upon the nose of the dust of bichromate of potash, and the disease manifests itself thus: A little hole is formed on the partition of the nose (dividing the two nostrils), and increases gradually until the partition entirely disappears, with the exception of the lower part of it, so that to a superficial observer there is nothing the matter with the nose except, perhaps, a little outward depression. It must be remarked that as soon as the partition is gone the process seems to stop there, and neither the lungs, air tubes, nor throat are in the least affected. Its influence is very different with different individuals. Some workmen, after having been employed for ten years at the works, remain unaffected; while with others the hole in the nose begins to be formed after one month's work. A general inspection of all the men at the works, not long ago, proved that more than fifty per cent of them had diseased noses. When the disease sets in first, the man feels tickling in the nose; a week or so after it bleeds, and in a few days more there is no uncomfortable feeling of any sort, and thus the hole is formed almost without any pain."

Dr. J. B. Trask, first State Geologist, was first to call attention to the deposits of chromic iron in California and their prospective value. In his report to the California Legislature, in 1853, he remarks upon the importance and the abundance of chromic iron in this State, specimens seen by him being declared equal to the best in the world. The principal localities known at that time were Nelson's Creek, at its junction with Feather River; between the North and Middle Fork of the American; on Bear River, four miles from Johnson's Ferry; in Coyote Diggings near Nevada; and on Deer Creek two miles from Nevada. Chromic iron is found in at least twenty-three counties in the State. Nearly all the localities are represented in the State Museum.

Alameda County, near the town of San Antonio. This locality has never been worked to any extent.

Amador County (1876), is from near Jackson; (2731), one mile south of Mountain Spring House.

Butte County (4678), Mount Hope district, near Forbestown.

Calaveras County (4470), near Murphy's, reported to be in considerable quantity. Campo Seco—a deposit of excellent quality, and said to be in quantity. This deposit can be worked to advantage when the narrow gauge S. F. & S. N. Railroad, is finished to Messenger's Valley, to which point it is nearly all graded. "In San Diego Gulch, on the east of the highest hill, opposite the Noble copper mine, is an isolated mass of chrome iron that will weigh thousands of tons."—[J. Ross Browne.] Specimens have been received, but not yet entered in the catalogue.

Del Norte County.—Chrome iron occurs north of the Low Divide copper mines, and at Smith's River, twenty miles from Crescent City. The ore is of good quality and has been quite extensively mined and shipped.

El Dorado County (960), ten miles west of Shingle Springs; (1402), exact locality not given; (2431), near Latrobe; ledge said to be from three to six feet thick.

Fresno County (1365), twenty miles from Fresno City, five specimens from as many districts, but all in the same neighborhood. A deposit of chromic iron was discovered in Fresno County in 1855, which was supposed to be silver ore. The excitement which followed led to the discovery of the New Idria quicksilver mine. The chrome ore lies in serpentine and exists in large quantities.

Lake County (4640), road from St. Helena to Knoxville, said to be in quantity.

Monterey County, near the San Benito River.

Napa County (797), near St. Helena.

Nevada County (5050), within two or three miles of Nevada City.

Placer County (3711), Michigan Bluffs; (3716), within one mile of Auburn; (5120), Section 21, Township 14 north, Range 9 east. At the Alabaster Cave there is an extensive deposit from which at least five hundred tons have been shipped. From the deposits in Placer County, located seven miles east of Iowa Hill (3711), shipments have been kept up quite steadily for the past year or two. This ore is of good quality and occurs imbedded in the country rock in disconnected bunches of irregular shape, and weighing from a few pounds up to several hundred tons each.

Sacramento County (1906), seven miles east of Folsom; (2768), near South Fork of the American River, nine miles from Folsom. Two thousand tons have been shipped from this locality. "Eight hundred tons of chrome iron now lying at Folsom. Two hundred tons shipped two weeks ago to San Francisco, to be sent as ballast to Baltimore. The ore comes from a distance of eight miles."—[S. W. Collins, May 18, 1880.]

San Francisco County.—Several unimportant deposits have been found on the peninsula of San Francisco. One on the ocean beach below the outlet of Lake Merced. No. (686) is from one of these localities.

San Luis Obispo County.—Chromic iron is particularly abundant in this county. The Flores vein, the leading mine in the San Luis Obispo group, has been explored by a tunnel two hundred feet long, which has opened up a fine body of good grade ore at a depth of nearly one hundred feet; (57) is from a deposit twelve miles from San Juan; (1578) is from the Pick and Shovel mine, six miles northeast from the City of San Luis Obispo. Up to July, 1880, four hundred tons of ore had been shipped; (2343) is from the London mine, four and a half miles northeast of the town. From the San Luis Obispo mines, located five miles southeast of the town, as much as five thousand tons per annum were taken for several years in succession. But little or nothing has, however, been done there of late, owing to the low prices ruling for chrome in the San Francisco market. Ezra Carpenter, in a letter of August 3, 1880, on file, gives the amount of chrome iron shipped from that port to date of letter, at 15,202 tons.

San Mateo County (2526), is from the Pacific slope of the redwoods. One sample selected assayed 50.12 per cent of chromic acid. The deposit is said to be large, but as yet no shipments of ore have been made.

Santa Clara County (394), is from a deposit five miles east of San José; (1154) is from Los Gatos.

Sierra County (4196), vicinity of the "Mountain House," near Downieville.

Siskiyou County (3601), high grade ore, half a mile from the town of Yreka.

Solano County (2772), found near the town of Fairfield.

Sonoma County (6), near Litton Springs; (174), four miles south of the town of Cloverdale. Mr. Edward Barnes mined and sold 2,000 tons from this deposit; 1,000 tons to Benjamin Flint; 500 tons to Cross & Co., and 500 tons to Kruse & Euler; cost to lay it down on wharf at Petaluma, $3 50 per ton, and at ships, $1 additional. Prices obtained as follows: To Kruse & Euler, and Benjaman Flint, $10 per ton; to Cross & Co., $7 50 per ton. The ore was found in bowlder form in serpentine. The original deposit was wholly exhausted, but Mr. Barnes thinks others might be found.

Tulare County (2493), was found ten miles from Portersville; quantity supposed to be considerable.

Tuolumne County.—The Engel mine is at York Tent, near Chinese Camp. The ore crops out boldly at several points, and at some of the croppings is four feet thick.

I am satisfied that the chrome ores of California are being sold too cheap. Of course, it is the policy of those who require these valuable ores to buy them at the lowest possible price, but it is not to the advantage of the State to deplete all the mines, and ship away the ores which should be saved for that time, not very far distant, when California will be a great manufacturing State. At the present ruinous prices, European consumers can afford to buy and store the ores, which the Californians are willing to dispose of at a trifle above cost of mining. The bane of the California miner and prospector is the desire to quickly realize on what he may discover. The rights of future generations, the requirements of manufactories yet to be established in the State, and the best interests of the State, are wholly ignored, in the selfish desire to get something for nothing, or to become rich without economy and labor. The same policy has caused enormous waste in the working of the rich ores of other metals in the State. The fact that half the mineral went to waste was no consideration, as long as the other half was made immediately available. There being little or no competition, those having ores to sell must take what is offered or allow them to remain in the mines, which, by far the best policy, does not meet the views of our miners. According to the recent report of Dr. James Hector, of the Geological Survey of New Zealand, chromic iron containing fifty per cent of chromic oxide is worth from eleven to twenty pounds sterling per ton ($53 to $97). This is from seven to twelve times the prices at which California chrome ores have been sold. Chrome iron imparts a green color to minerals and rocks with which it is associated. There is a variety of serpentine highly prized as an ornamental stone, known as "verd antique" (*vert antique*), oppiolite (*verde antico*) of the Italians and ancient Romans, which is a green serpentine, sometimes brecciated with strings of white steatite or noble serpentine veining it beautifully. It receives a high polish, but will not withstand the action of time. "*Verde di Prato*" is found in the Apennines, a few miles from Florence. It was largely used in the interior decoration of the Cathedral of Florence. "*Verde de Genova*" is found, as the name indicates, near Genoa. It contains veins of white and light green calc spar in green serpentine. These ornamental stones are again mentioned here in the hope that some prospector may search for and haply find a deposit of verd antique among the numerous localities of serpentine and chrome iron in California. The most of the chromic iron that has heretofore left the country has been sent, in the first instance, to San Francisco, and thence shipped around Cape Horn. More recently consignments are being made via the Isthmus, or overland by rail, small lots from the Placer County mines having gone forward during the past year by both of these routes.

PRODUCTION IN CALIFORNIA.

In attempts to gain information as to the quantity of ore raised in California, the State Mineralogist has met with so much opposition from those who are interested to conceal the amount, that no reliable data can be given. Steps will be taken in the future, that will probably result in obtaining the information, which will be given in reports to follow this. It may, however, be said, that the quantity is much larger than would generally be supposed by those who have given the matter no special attention.

Chrome Spinel—See Picotite.

36. CHRYSOCOLLA. "*Gold Glue*" (Greek).

A green mineral passing to sky blue. H. 2—4, sp. gr. 2—2.24, luster vitreous to earthy, streak white. It is a hydrous silicate of copper ($CuO, SiO_2 + HO$) and when pure has the following composition:

Oxide of copper	45.3
Silica	34.2
Water	20.5
	100.0

It is more generally impure than the reverse, and often forms one of a group of copper minerals. B. B. decrepitates and colors the flame green, but does not melt. In a closed tube it gives water and turns black. With fluxes, yields a globule of copper. It is a rather abundant mineral in Southern California, being regarded in Owen's River Valley as an indication of silver mines. It is found as a stain on rocks in the vicinity of the croppings of silver and copper mines and with other minerals in the veins. No. (5926) is a fine specimen from the Copper World mine, San Bernardino County; (5158) is an association of chrysocolla, cerargyrite, and cuprite in beautiful microscropic crystals, from Lundy, Mono County; (1433) is from the Union mine, Inyo County; (2342) from forty miles south of Colton, San Bernardino County. It occurs also near San Carlos, Inyo County; at the Eclipse mine, same county; in the White Mountains, Mono County; in San Diego and San Luis Obispo Counties, and elsewhere in the State. It is a valuable ore of copper, for the reason that it can be easily reduced in the water jacket furnace to metallic copper.

37. CHRYSOTILE.

This is a magnesian mineral, a variety of serpentine, having no economic value. It occurs in veins or seams in serpentine, and is not uncommon in the State where the serpentines occur.

Cinnabar—See Quicksilver.

38. CLAY.

Clay may be defined as a hydrated silicate of alumina, contaminated, more or less, by various impurities mechanically intermixed with it. It is frequently colored by metallic oxides, and generally contains a small quantity of alkali. Clay is the product of decomposed crystalline rocks, brought down by the streams in former ages and deposited on the bottoms of lakes, seas, and other bodies of water. Glacial action has, no doubt, assisted the work of comminuting these rocks.

Pure clay when thoroughly incorporated with water becomes plastic, but when baked loses this property and becomes hard. As it shrinks in baking something has to be added to counteract this tendency. The nature of this addition differs with the requirements of the potter, and to determine what this should be often severely tests his skill. For making some varieties of porcelain a portion of infusorial earth is mixed with the clay. For making some other fine wares, quartz and feldspar are used, powdered brick, sand, etc., being employed for the coarser varieties. The addition of these foreign substances diminishes the plasticity of the clay and renders it more porous. Vessels intended to hold fluids, before being baked, are coated with a material that, fusing readily, acts as a flux, and glazing the surface fills up the pores. Unglazed pottery is called terra cotta. Porcelain is glazed by being dipped into a thin mud of finely powdered feldspar.

Besides the addition of these foreign substances all clays, except when used for the most common purposes, require to be subjected to a washing, sifting, and grinding process. They are also improved through exposure to the frosts and Winter rains, whereby a certain amount of decomposition takes place that relieves them of their impurities or renders the latter harmless.

OCCURRENCE IN CALIFORNIA.

The useful clays of every variety and degree of excellence are found at many places in this State. Of these, the following are the principal: At the town of Lincoln, on the Oregon Division of the Central Pacific Railroad, Placer County; at Michigan Bar and at Cook's Bar on the Cosumnes River, Sacramento County; near the Cities of San José and San Francisco, and at various places in Sonoma, Napa, Humboldt, Tehama, Contra Costa, Alameda, Calaveras, Inyo, Monterey, Los Angeles, and San Bernardino Counties. While the clay found at one locality, at least, is suitable for making the finest of earthenwares, a great deal of it answers well for making all the coarser varieties, as well, also, as vitrified ironstone pipe, fire-brick, crucibles, and other articles required to resist a high degree of heat. The Michigan Bar clay being well adapted for the manufacture of ironstone crockery, most of the potteries throughout the State obtain there the material for manufacturing this class of wares. The deposit in San Francisco, unless mixed with a better clay, is fit for making only the more cheap and common kinds of articles.

Elsewhere in this Country.—The occurrence of the useful clays is not confined to California. They are found in most of the other States of the Union, also in the Territories, being very abundant in the most of them. Coarse pottery of various kinds is made in New Mexico, Colorado, Utah, and Oregon; also fire-bricks—a great many of them in Colorado, Utah, and Montana. In several of the Eastern States, fire-bricks, tiles, stone-iron pipe, terra cotta, and the more common kinds of crockery are extensively manufactured; a very fair article of porcelain being also made in New Jersey and some other of the Atlantic States.

Kaolin.—During the year 1883 a deposit of this valuable clay was discovered near the town of Calico, in San Bernardino County. The finding of this mineral has frequently before been announced, but the material which gave rise to such announcements, on investigation, turned out to be something quite different, generally infusorial or diatomaceous earth, which, to the unassisted eye, has much the appearance of kaolin. Examined, however, under a microscope, the difference becomes clearly apparent, identifying this mineral without recourse to a chemical analysis.

Fire-bricks.—While we have in California clays of, perhaps, as good quality as are found elsewhere, we have not as yet done much towards supplying ourselves with fire-bricks, or other articles of a highly refractory kind. The principal reason for this has been the low prices at which the English bricks have sold in this market, being often brought as ballast on ships coming here to load with wheat. They are now selling in San Francisco at $30@$35 per 1,000, a price at which we can hardly afford to make and deliver them in the city, the principal distributing point on the coast. It may be, too, that our manufacturers have not always used as much care in making these articles as they should have done; nor, perhaps, has the clay employed been always of the best kind. We know, from many trials made, that we have good, if not the very best, of clays for this purpose; and if some of our home-made bricks have not given satisfaction, it may have been because good clays were not selected; or, more likely, because there was a lack of skill or care in making them. Deposits of first class fire clay are scarce even in England, and when found are considered very valuable. Neither in England nor France are the fire-bricks of uniform excellence, owing to difference in the quality of the clays from which they are made. The properties most desirable in a brick of this kind are ability to resist intense and long continued heat, sudden extremes of temperature, great pressure, and the action of corrosive substances; hence the value of a clay that fulfills, or comes nearest to fulfilling, these conditions. The term fire-proof clay is comparative, there being no clay that will resist the heat at which platinum melts. A brick may be said to be fire-proof that will answer the particular purpose for which it is required. All clays intended for the manufacture of fire-bricks should, however, be free from the oxide of iron, contain but little potash or soda, and be mixed with fifty to sixty per cent pulverized fire-brick, or baked clay.

The firm of Gladding, McBean & Company has placed in the State Museum samples of such of their clays as have been analyzed, both those used for the manufacture of fire-bricks and pottery wares, an example that should be followed by others in the business.

As the consumption on this coast is large and likely to increase, it may be expected that we will soon supply the demand, in good part, with fire-bricks of domestic make, fully half a million dollars having heretofore been paid out every year for English bricks and clay, some of the latter being also imported. An extensive bed of fire clay was discovered not long since in Inyo County, and having been tested in the cupola furnaces there, and found to stand well, this material will be likely to come into considerable use, as many structures of the kind will, in the course of time, be needed in that region, which abounds with rich galena and other ores requiring to be reduced by smelting.

OUR POTTERIES AND THEIR PRODUCTS.

Owing to the rather bulky and fragile character of this class of wares, works for manufacturing the coarser kinds of pottery were started in California at an early day. Although most of these pioneer establishments have gone out of existence, we have at the present time eleven potteries running in the State, besides several works at which drain and water pipes are made from cement. As yet not much, except the more cheap and common articles, have been produced here, such as vitrified iron-stone pipes, terra cotta, coarse earthenware, tiles, etc. Some little glazed yellow ware and other of the better grades of crockery have been made, and now that kaolin has been found in the State, it is probable something better than has yet been produced in this department will be attempted. The climate of California, by reason of our long dry Summers and even temperature, greatly favors the prosecution of this industry. Our imports in this line have been heavy, amounting to three thousand packages per annum—exports about half that number of packages, the most of them sent to Western Mexico, Central America, the Sandwich Islands, and British America. The largest establishment of this kind in the State is—

The Pottery of Gladding, McBean & Company, located at the town of Lincoln, Placer County, on the line of the Oregon Division of the Central Pacific Railroad. At this point the above company have put up capacious works, the main building being 160x230 feet, a portion of it three and the balance two stories high. Commenced in 1875, these works have since been from time to time enlarged, covering now two acres of inclosed floor-room. The machinery and apparatus here in use are of the most approved patterns, the whole being operated by a sixty-horse power engine. The deposit of clay at this point is of good quality, and very extensive, being between twenty and thirty feet thick and covering many acres. The articles made at this pottery consist of iron-stone crockery, and pipes for the conveyance of water, drainage, sewage, etc.; fire-bricks, architectural and ornamental terra cotta wares; fire, drainage, and sub-irrigation tiles; culvert pipes, well tubing, water filters and coolers; stove and flue lining, acid receivers, vases, flower pots, baskets, and boxes; water-closet bowls, slop-hoppers, grease traps, etc., the goods turned out here fairly representing those made at most of the other potteries in the State. This firm employs altogether about one hundred men. Their general depot and business office is at 1336 Market Street, City of San Francisco.

The Other Potteries in California consist of the following: The Pacific—proprietors, N. Clark & Sons—works, Sacramento; principal office and depot in San Francisco; employ eighty hands; obtain most of their clay from Michigan Bar, and manufacture nearly all the wares above enumerated. Andrew Steiger, at the City of San José, employs fifteen men, and makes a variety of articles, sewer pipe largely. Henry F. Bundock and George Maddox, having small potteries in Sacramento, employ from four to six hands each, and make not much except iron-stone crockery. The California Pottery and Terra Cotta Company, Miller & Windsor proprietors, have extensive and well equipped works at East Oakland; they employ forty-eight hands; obtain their clay from Michigan Bar, Sacramento County, and make ornamental terra cotta, vases, moldings, and trimmings for buildings, sewer pipes, etc.; office and depot in San Francisco, with a branch office in Oakland, and another in Portland, Oregon. Daniel Brannan works in Oakland, employs four to six men, and makes little besides flower pots and acid wares. Dennison & Son, Napa City, who employ from six to eight men, turn out only drain tiles. The Mission Pottery, located near the corner of Seventeenth and Harrison Streets, San Francisco, yard and office on Market Street, employs twenty hands, and manufactures iron-stone sewer pipe, coarse crockery, terra cotta ware, etc. This company have a small pottery at Michigan Bar, not running of late, though it is their purpose to start it up soon. They also own the deposit of clay at that place, which, being especially well suited for making stone crockery, is supplied to several of the other factories that make this class of ware. This material is also brought to San Francisco and mixed with the rather poor clays found in the vicinity of the city, so improving them that they can be used for making coarse articles to advantage.

A pottery of limited capacity was built not long since near Korbel's Mills, in Sonoma County, for making glazed earthenware from clay found in that neighborhood. A similar establishment was put up last year at Los Angeles, by Messrs. Hazzard & Earl; deposits of good clay occurring at a number of points not far from that city. The Albion Pottery, located at Antioch, and one of the earliest started in the State, has not been running for some years past, and will probably not again resume operations. It turned out at one time large quantities of fire-bricks, crucibles, stoneware, etc., made from clay found in a seam in the Black Diamond coal mine near by. One of the pioneer potteries of San Francisco, standing near the foot of Sixth Street, was some years ago converted into a sulphur refinery, for which purpose it has since been used.

CONDITION AND PROSPECTS OF THE INDUSTRY IN THIS STATE.

The potters about San Francisco, and elsewhere near the coast, keep up operations the year round. In the interior of the State, not much is done during the Winter, except at the larger establishments, where the processes are carried on mostly within doors. The capital invested in this line of business in California amounts to about three hundred and fifty thousand dollars; total number of hands employed, two hundred and seventy-five—one fourth of them, Chinese; most of the smaller works, however, employ only whites; wages paid vary from $1—paid the Chinese—to $2 50 per day; working by the piece, a common practice, skillful hands make from $3 50 to $4 per day.

The practice that has largely prevailed in this market of importing English crockery by the cargo, and selling it at auction, has forced our local manufacturers to so improve their wares, both as regards elegance of design and intrinsic merit, that they now compare favorably with foreign articles of the same grades; and it may safely be predicted that this branch of manufacture will so grow and improve as to greatly curtail, and perhaps wholly exclude, importations in the course of a few years. The demand for stone-iron pipe, for house and street sewerage, must necessarily increase rapidly, by reason of its great superiority for such purposes; while the requirements for flower pots, vases, and terra cotta wares, for the adornment of buildings, gardens, parks, pleasure grounds, etc., may be expected to keep pace with the increase of population and the growth of æsthetic culture among our people. Being so well provided with the raw material, it may be expected that works for manufacturing the higher grades of pottery, including, perhaps, porcelain wares, will very soon be established in California. We have here not only the clays, but also all the other ingredients required for making both the common and the finer kinds of pottery; quartz for supplying the silica, feldspar, lead, borax, and soda, being abundant in this State.

THE BUSINESS ELSEWHERE IN THE UNITED STATES.

There is a pottery in Oregon, also one in Utah, and several in Colorado, the number of these works in the United States amounting, according to the census report of 1880, to 686; the whole giving employment to 8,494 hands, using up $2,564,359 worth of raw material, and turning out manufactured products to the value of $7,942,729 annually; capital invested, $6,380,610; expended in payment of wages, $3,279,535 per year. In the same year there were in this country 5,631 establishments devoted to the manufacture of brick, tile, drain pipe, etc.; they had an invested capital of $27,673,616, employed 66,355 hands, paid $13,443,532 in wages, used up $9,774,834 worth of material, including fuel, made 3,822,362,000 common brick, 163,184,000 fire-brick, 210,815,000 pressed brick, $2,944,239 worth of tile, $1,765,428 worth of drain pipe, $719,926 worth of all other articles, and had a total value of all products of $32,833,587.

HISTORY AND PROGRESS OF THE CERAMIC ART.

The art of molding the plastic clays into useful and elegant forms is one of great antiquity, having been practiced by the more enlightened nations from the earliest periods of which we have any record, and even perhaps by those of prehistoric times. Indeed, there is reason to suppose that in the broken pottery, inscribed bricks and other ceramic relics, dug up in various parts of the world of late years, we have all that remains of races who once existed, but of whose presence on this planet every trace, save only these simple impressions in clay, has been extinguished. Scattered over the valleys and mesas of northwestern Mexico and of Arizona are to be seen fragments of pottery made probably by a people of whom there is left not even so much as a tradition, they having disappeared before the Toltecs, their successors, came to occupy those regions. Babylon and Nineveh are gone—so nearly obliterated that it is difficult now to identify the sites they occupied; but the Assyrian tablets and the cunieform inscriptions remain to attest the existence of these once mighty cities. Burned into the indestructible clay, more enduring than granite or marble, these simple characters survive to tell in disjointed sentences the story of the past. The initials C. H. impressed in the brick of which our new City Hall is built, put there to denote that they were intended for that edifice, may (should they prove to possess the lasting properties claimed for them) become to the antiquary of the remote future a source of much worriment as he labors to decipher their probable meaning.

THE ART IN MODERN TIMES.

Though so generally practical and held in such high esteem by the ancients, the ceramic art has been hardly less appreciated in later years, the demand for its products having kept pace with the progress of æsthetics and the culture of public taste. Requirements in this line of production, both for purposes of utility and ornamentation, are growing rapidly, as is shown by the number of men engaged in the business, and the extent to which articles of this kind are being introduced in building, as well as for embellishing grounds, etc.

So far as the making the very finest grades of pottery are concerned, the Chinese and Japanese have in recent times divided the art between them, for which reason the name "China" has been given to this class of wares; the term "porcelain," by which also they are known, being derived from *cyprea porcellana*, which shell they resemble. For a long time the Europeans obtained these fine wares exclusively from the Orient, but finding at length excellent clays at home their own artisans began to imitate them very closely. In the year 1710, Frederick Bottcher having put up rude works at Meissen in Saxony, succeeded in making pottery much resembling the Chinese article, and a deposit of kaolin having afterwards been found near by, such importance was attached to it, that its exportation was prohibited under the severest penalties.

In 1765, the extensive deposit of fine clay at Sevres, France, having been discovered, works were put up there, at which, under the supervision of the Government, there have continued to be manufactured large quantities of porcelain ware ever since. In connection with these works a ceramic museum has been established at that place.

The clay deposits of New Jersey, in connection with the potteries erected for utilizing this material, are of great economic value to that State, these works giving employment to a large number of men, while their products find market in all parts of the Union; and yet, as before remarked, there is little doubt but equally good clays exist in various other parts of the country, it having been proved that we have such deposits in California, though their extent has not yet been fully established.

BRICKS.

Owing to the destructive fires that were of such frequent occurrence in the towns of California during the early history of the State, bricks coming into large demand for building purposes, the business of making them was extensively engaged in, brickyards having been started all over the State. Of late years we have manufactured these articles at the rate of perhaps 250,000,000 per year, more than one half being used in and about the city of San Francisco, in the vicinity of which a large proportion of them are made, notwithstanding little really good clay is found there. Since the more compact portions of the larger towns were built up we have consumed comparatively few bricks, most buildings put up in the country and outside the fire limits in the cities being constructed of wood. The adobe, a large sun-dried brick, was, in early times, the only material used for the walls of dwellings, and in fact for structures of every kind, the corrals, churches, presidios, everything, being composed of this cheap unburnt brick, which, when protected from the rains, stands for a long time. In sections of the country largely inhabited by Mexicans, native Californians, or other races of Spanish descent, as well, also, as in localities where lumber is scarce, the adobe is still much employed in the erection of dwellings, corrals, etc.

Nearly all our large factories, foundries, woolen mills, churches, suburban residences, and country villas, and, in some instances, even our educational institutions, are built of wood. We have, however, a good many structures in which a large number of bricks have been used. Into the Palace Hotel, San Francisco, 23,000,000 bricks have been laid, nearly as many having been disposed of in the construction of Fort Point. One reason that lumber has been so generally employed here in building is its greater cheapness and convenience as compared with bricks. Then the kind mostly used for this purpose, the redwood, is easily worked, never warps, and is very durable, lasting, even when exposed to the weather, for a very long time. Sticks of this timber in the old Mission churches of California remain as sound as when put in place a hundred years ago.

In selecting a site for his business the California brick-maker has been embarrassed by the twofold trouble of securing cheap transportation to market and a sufficiency of clay suitable for his purpose, the latter not always an easy thing to do in California. Sometimes our clays show an excess or deficiency of sand, while again they are contaminated with alkali, magnesia, or other objectionable mineral. As much of our clay is of an inferior quality so are the beds apt to be superficial, few of them anywhere having a depth of more than fifteen or twenty feet, those about San Francisco being even more shallow.

A great many bricks are made near the cities of San José, Stockton, and Sacramento, at all of which a tolerably good clay is found. The pressed bricks made at San José are said to be nearly equal to the Philadelphia article, than which there are probably no better made anywhere. As many as six or seven million bricks per year have been turned out at the San Quentin State Prison, all marketed in San Francisco.

In the manufacture of bricks two methods are employed in this State, the old one of burning in kilns and a new method known as the Hoffman process, by which they are baked in furnaces, some of which are capable of holding nearly half a million at a batch. The advantages of this system consist in a saving of time, a batch being burned in about a day and a half, and in the ability to continue operations during the Winter, when by the old plan they have to be suspended, the working season in that case extending only from April to November. The price of bricks in San Francisco varies from $9 to $10 per 1,000 for ordinary, and from $25 to $30 per 1,000 for pressed. This business, in which there is hardly less than $1,000,000 invested, gives employment, directly and indirectly, to about 1,700 men during the six dry months of the year, and to about one third that number during the wet season, a third of the whole being Chinamen.

Burners in this business receive $70 per month; molders and setters $45, and ordinary hands $35 to $40 per month, board in all cases being included—Chinese, less these rates by thirty-five per cent.

CEMENT PIPE—ITS MANUFACTURE AND USE.

We have in California a number of establishments for the manufacture of this class of products, of which some mention may here properly be made. Not much pipe of this kind has been made in the city of late, its use having in great measure been prohibited by the municipal authorities. Very extensive works for its manufacture have, however, been put up at Ontario, in San Bernardino County, where great quantities are being turned out for use in that neighborhood. This pipe is employed mainly for the drainage of grounds and the conveyance of water, for which purposes it answers extremely well. As a water conduit it is especially valuable, being cheap, healthful, and capable of withstanding considerable pressure. A great deal of it will hereafter be required in California, as we will have much land to drain; then, water running in flumes or open ditches undergoes such waste in this hot and arid climate, that it will be found economical to carry it largely in pipes, whereby it will be protected from evaporation and absorption. The extent to which irrigation must come to be practiced in this country, makes our prospective wants, in this direction, very large. Vitrified clay sewer pipe is made by machinery, the clay being forced by a plunger through a cylinder, in which there has been placed a core, the sections or joints, cut off in three-foot lengths, being set on end in a well aired room to dry. The socket for the joint is pressed in a plaster mold, and poured in while the clay is damp. When perfectly dry, the joints are dipped into a vat containing water, holding a substance known as Albany slip in solution. After being again dried, they are hard burned.

Coal—see Mineral Coal.

Cobalt—see Erythrite and Millerite.

Cobalt Bloom—see Erythrite.

39. COCCINITE. Iodide of Mercury.

Locality given by Dana, San Emidio Cañon, Kern County.

Colemanite—see Priceite.

40. COPPER. Etym. *Cuprum* (Lat.).

Copper has a wide distribution in nature, being found in most parts of the world. It is one of the few metals that occurs in the metallic state in nature, for which reason it was in use by primitive man long before he learned to extract it from its ores. It also possesses properties that impart to it a special value. It is malleable alone, but may be hardened by alloying with other metals, as with tin, producing bronze, and with zinc, producing brass. It fuses readily, and when polished is a beautiful metal, possessing a rich color and considerable luster. Copper was an article of commerce in America in the time of the mound builders, and perhaps earlier, as the mines of metallic copper, on the shores of Lake Superior, appear to have been extensively worked by a people concerning whom there exists now no tradition or record. In the days of the alchymists copper was named from Venus, and given the same astronomical sign. In later times this metal has become indispensable, and it is fortunate that its distribution is so general over the surface of the earth. While some of its ores have been found very rich, the greater portion of the world's product has been obtained from those of low grade. This has heretofore not been generally understood, especially in California, where, not until recently, have any attempts been made to utilize the poorer varieties of ore.

PRODUCTIVE LOCALITIES IN THIS STATE—THE COPPEROPOLIS MINES.

While it is well known that copper ore occurs at a great many places in California, we are still much in the dark as to the extent and value of our cupriferous deposits, so little have they as yet been exploited. Dr. John B. Trask, first State Geologist, reported finding the ores of this metal in almost every county in California. Although this was the first officially recorded discovery of copper in the State, its existence here had been well known long before. The localities at which more or less work has been performed, and considerable quantities of ore have been extracted, are the following, there being many others where the occurrence of the ore has been observed and some exploratory work done: At Copperopolis, Calaveras County, where a large body of good ore was discovered in the Union mine in the Summer of 1861. Afterwards this deposit was extensively exploited, over 60,000 tons of ore having been extracted from it during the next six years, when, by reason of diminished ore supply, litigation, and lower prices for copper, work on this and adjacent mines was suspended, and has never since been resumed. From the Empire, Keystone, and various other claims in the vicinity of the Union, several thousand tons of copper ore were taken during the above period, nearly all of which was shipped to Liverpool, at a cost (freights and other charges included) of about $25 per ton, this being aside from cost of mining, sacks, etc. Owing to these heavy expenses, no ore carrying less than 10 per cent metal was ever shipped from these mines, the Union ore sent away having averaged about 15, and that from the other mines about 16 per cent. At the time operations were suspended on the Union mine the lode had been opened up to a perpendicular depth of 500 feet, at which point it showed a width of 15 feet, and still carried a good body of medium grade ore. The depth reached on some of the other mines on the range was nearly as great, the show for ore on these being also tolerably good when work was closed down in 1867.

This Copperopolis find led to much prospecting for and the discovery of numerous other deposits of copper ore in California, a good deal of money having been expended in the search, and afterwards in opening up mines and supplying them with plant, between the years 1861 and 1868.

THE CAMPO SECO MINE.

During the period above mentioned a deposit of copper ore was discovered one and a half miles from the town of Campo Seco, Calaveras County, in a heavy cupriferous belt that here traverses the country. Furnaces were put up here at an early day, and a railroad built connecting them with the mine, which, at the time of my visit, I found had been opened by a vertical shaft 275 feet deep, and by three levels, 80, 140, and 200 feet deep respectively. From Mr. C. Berger, Superintendent, I learned that the vein is well defined in a country of slate; course of vein, northeast and southwest; dip, 62° S. E. In his opinion there is here a large body of ore that will average ten per cent copper. The hoisting-works are driven by water communicated by an ordinary hurdy wheel at a cost for water of three dollars per day. The ores are generally chalcopyrite with some bornite and iron pyrites. The reduction works put up here are extensive and complete. The ores after being passed through a rock-breaker are dry-crushed by a Dodge pulverizer, and passed through a 40-mesh screen at the rate of twenty-five tons per day. Falling into a chamber, the dry pulp is carried from this to a more elevated chamber, and thence fed into a Dodge rotary roaster, lined with fire-bricks. As this furnace, which is forty feet long and octagonal in form, slowly revolves, the ore falls from each interior face in a succession of drops, while the reverberatory flame passes through from end to end; the ore at the same time moves slowly forward and finally drops into a receiving chamber of brick. The roasting is so managed that the sulphur in the ore is oxidized to form sulphate of copper. The operation is checked from time to time by withdrawing a portion of ore, and shaking it up in a test tube with water and ammonia, when it yields a blue solution, which is compared with similar solutions of known strength. This, added to preliminary assays of the raw ore, gives data by which the roasting may be regulated. The roasted ore is withdrawn from time to time from the receiving chamber, and extracted with water in large brick vats set at a slightly lower level. The solution containing sulphate of copper is drawn into similar vats at a still lower level, into which scrap iron has been placed. In these vats sulphuric acid leaves the copper and takes an equivalent of iron, for which it has a greater affinity, forming basic sulphate of iron, which is drawn off and allowed to go to waste, although its value is well known. The cement copper is then detached from the iron scraps, dried, placed in bags, and sent to San Francisco, and a market. After a brief trial of the above method these works were shut down, and have since so remained, but whether in consequence of defects in the process employed, or the low price of cement, we are not advised. Cement copper, which a few years ago commanded eighteen cents per pound for eighty-five per cent, can now be sold for only twelve cents for one hundred per cent, or at that rate.

Commencing in 1869 and continuing until 1873, Mr. E. T. Stein treated the low grade ores from the Napoleon mine by the Haskell patent process, whereby the liquors from which the copper has been precipitated are required to be returned to the heaps for a second operation. Except in this particular, the Haskell process differs not materially from that above described. Mr. Stein made twelve tons of good quality Venetian red from his waste solutions, and found the business, while engaged in it, fairly profitable.

THE SATELLITE MINE AND WORKS.

This mine, now owned by Horace D. Ranlett, of San Francisco, is the old Lancha Plana under a new name. It is situated one and a quarter miles from the town of Campo Seco, and lies on the southeast quarter of Section 4, Township 4 north, Range 10 east, Mount Diablo meridian, and appears to be on the same belt with the Campo Seco mine, both having been discovered in 1861. Extensive reduction works, including a smelter, were put up here in 1865–6, at which time as many as one hundred and fifty men were employed about the mines and works. The ground is opened by two shafts, three hundred feet apart; the one represented to be three hundred and the other four hundred feet deep—the two being connected by a level. There were formerly extracted from this mine large quantities of rather low grade pyritic ores, which are now being leached. From the bottom of a winze put down from a new level, over a ton of metallic copper, consisting of magnificent specimens, has been extracted, also masses of ore largely melaconite, and containing granules of native copper. These ores occur in a shistose rock having a nearly vertical dip, and which is capped by a heavy deposit of gravel, formerly worked for gold, and not yet exhausted. Latterly, some two thousand tons, composed mostly of oxidized ores, have been raised here, about one fourth of which was shipped to Baltimore and the remainder placed on the heaps now being leached. The copper-bearing minerals observed here consist of chalcopyrite, bornite, melanconite, azurite, and chalcanthite, with quartz, barite, slate, serpentine, and a rock resembling diorite. Although generally of low grade some of the ore found in this mine is extremely rich, the stock appearing to be ample to keep the reduction works employed for a considerable time.

These works, erected at a cost of $2,500, differ but little from those of the Sunrise Company, the roasting being conducted on the same principle. Scrap iron delivered at the mine costs from $10 to $20 per ton in carloads, freight being from $3 to $4 per ton. Burson, the new station on the San Joaquin and Sierra Nevada Railroad, is about four miles from the mine, the latter being twenty-three miles easterly from the town of Lodi on the Central Pacific Railroad. Water can be procured from the Mokelumne and Campo Seco Canal and Mining Company by laying a pipe one thousand feet in length, whereby a fall of one hundred and seventy-five feet can be obtained, affording a fifty-horse power at an estimated cost of $8 per day. The copper cement produced at this mine is sent principally to Boston, Baltimore, and New York, with a little also to Liverpool.

The Little Satellite, an extension of the Satellite, and formerly called the Star, is also owned by Mr. Ranlett. It lies parallel to the Campo Seco mine, and shows good indications of ore, having recently been opened by a tunnel. From the old Star shaft considerable ore was extracted at a depth of ninety feet.

SUNRISE MINES AND WORKS.

Situated on the banks of the Mokelumne River, two miles from Campo Seco, are the Sunrise Placer Mining and Copper Reduction Works. The material operated upon here consists of the low grade ore taken from the old dumps of the Campo Seco copper mine, the business being conducted on an extensive scale, and, it appears, with very satisfactory results. Two methods of treatment are employed here. By one of these the ores are roasted, and by the other not. By the former, the higher sulphuretted ores are piled up in heaps, on a foundation of rough stones. Along this foundation work, at intervals of ten to fifteen feet, arches are formed, connected with vents in the chimney. The ore having been piled on these arches, the firing is commenced in them by burning wood; when sufficient heat has been produced to start the burning of the sulphur, the whole pile is covered with earth, and the air excluded, except small quantities entering the orifices at the several fire places. The sulphur continues slowly burning for from five to seven months. White fumes of sulphurous acid escape from the chimney, forming beautiful crystals of sulphur about the vents. The operation is ended when no more fumes are seen to escape, after which all the vents are closed and the pile allowed to cool. The roasted ore is then treated like the raw ores by the second process.

The raw ores containing much sulphuret of iron are placed on beds of rough and rather large stones, the beds being horizontal and loosely piled. The foundation upon which the rough stones are placed is slightly inclined towards the collection and precipitating tanks on the river bank, and is made water-tight with cement. The water supply is obtained from a reservoir fed from a mining ditch near by, this reservoir being connected with the ore beds by small iron pipes. To the ends of these pipes flexible hose are attached, ending in sprinklers, which throw a gentle spray over the piles of pyrites. The water sinks through the loose ore and assists in oxidizing the iron and copper pyrites to sulphates, which are dissolved by the percolating stream that flows into a collecting cistern, whence they are conducted to a series of sluices placed nearly level and in which large quantities of scrap iron have been thrown. The copper is precipitated but the sulphate of iron remains in solution and is allowed to go to waste. When the copper has accumulated in sufficient quantities the iron scraps are washed in a tank, whereby the copper is removed from the larger pieces, which are returned to the sluices for a fresh operation. To remove the smaller pieces of iron which result from the rapid solution of that metal, the cement copper is washed in a cradle on a punched screen through which the pulpy copper passes while the metallic iron remains behind. The cement is then dried artificially and packed in bags for shipment. The operation is simple and requires but few workmen, while the yield is very satisfactory. Messrs. F. W. and C. S. Utter, proprietors of these works, are also treating in a similar manner the ores from the old Napoleon and Empire mines near Quail Hill, Calaveras County. Mr. C. S. Utter, the superintendent, estimates the production of cement copper per annum at 9 tons to each man employed. The yield of the Sunrise works is about 40 tons per year. In the above described process the sulphur and the iron are wasted, both of which should be saved. In roasting the crude ores the sulphur could be saved as sulphur or made into sulphuric acid. The large quantity of metallic iron scraps used for reducing the copper is changed in the process into basic sulphate of iron, also allowed to go to waste. The solutions containing it should, however, be run off into shallow tanks and evaporated to dryness by the heat of the sun. This dry residue sent to San Francisco could be converted into Venetian red by simple calcination, or be treated with sulphuric acid and crystallized into green vitriol or sulphate of iron, which is the best of all disinfectants for sewers and closets, and has uses in many of the arts. It is to be hoped that this valuable product will hereafter be saved and turned to profitable account.

THE SPENCEVILLE MINES AND REDUCTION WORKS.

These mines, owned and operated by the San Francisco Copper Mining Company, are situated at the town of Spenceville, Nevada County, twenty miles east from Marysville, and at an elevation of 400 feet above sea level. The company's claim, consisting of 3,000 feet, forms part of the broad copper-bearing zone that crosses this region in a northerly and southerly direction, and which, during the era of copper excitement, already alluded to, was the site of great activity, thousands of claims having been taken up and much work done upon them. As the excitement died out, these claims were gradually abandoned. After a time, Mr. C. Berger began experimenting on these ores, and becoming satisfied that they could be made to pay under proper treatment, the above company was formed and commenced operations, the method of reduction in use here differing but little from that employed at Campo Seco. The works of this company are very extensive, as are also the developments made on the lode, which is worked after the manner of an open quarry. The excavation opened covers nearly an acre, and has been worked to a depth of about 100 feet. The ore is brought out on cars running on an incline. The hoisting works, mill, roasting sheds, leaching vats, etc., cover several acres, the improvements made by the company having cost over $100,000. They employ a working force of seventy-five men in and about the mines, besides wood-choppers, teamsters, etc., and turn out monthly about forty-five tons of copper cement, averaging eighty-five per cent metal. They keep a large supply of ore constantly on hand, there being, it is said, heavy reserves exposed in their mine, which will assay from three to five per cent copper; the ore worked averaging four per cent copper. The operations of this company are and for several years past have been paying a fair per cent on their investment.

The Newton mine, in Amador County, continues to turn out copper cement in limited quantities, and with some profit; there being several other mines, in different parts of the State, that are extracting ore in small lots, the most of which are sent to the San Francisco market.

The following are given, with authorities, as some of the localities in which copper occurs in California:

Cow Creek, Shasta County (1751); with Azurite, Telegraph mine, Hog Hill, Calaveras County (2401); Iron Mountain, Shasta County; Union mine, Calaveras County; Dendritic or Mess Copper (Blake); Keystone mine, Calaveras County (Blake); Napoleon and Lancha Plana mines, Calaveras County, and Cosumnes mine, Sacramento County (Blake); Santa Barbara County, disseminated in grains in serpentine rocks (Blake). It occurs with Rhodonite at Mumford's Hill, Plumas County (Edman).

PRODUCTION MADE ON THE PACIFIC COAST.

The metallic copper or its equivalent in ores produced on this coast may be set down for the year 1883 as follows: California, 700 tons; Nevada, 500 tons; Arizona, 10,000 tons; Montana, 8,800 tons; a total of 20,000 tons; this industry in the above Territories being now in a very flourishing condition. During the year 1882, there were shipped from San Francisco to England by sea 864,700 pounds of copper ore, and by rail east 126,541 pounds of copper, 1,795,104 pounds of copper cement, and 100,000 pounds of copper ore; the shipments of these several products for the past year having been a little larger.

FOREIGN PRODUCT.

We copy from the New York Engineering and Mining Journal the following table, compiled by Messrs. Harry R. Merton & Co., of London, showing the production of copper made in the countries mentioned during the past five years; the figures marked with a star being estimates:

	1883. Tons.	1882. Tons.	1881. Tons.	1880. Tons.	1879. Tons.
Algiers	*600	*600	*600	*500	*500
Argentine Republic	293	800	307	*300	*300
Australia	*12,000	*8,950	10,000	9,700	9,500
Austria	*500	*455	455	470	245
Bolivia—					
Corocoro	*3,250	3,250	2,655	*2,000	*2,000
Chili	41,099	42,909	37,989	42,916	49,318
Cape of Good Hope—					
Cape Copper Company	5,000	5,000	5,087	5,038	4,328
Canada	329	221	50	*50	*50
England	*3,000	3,464	3,875	3,662	3,462
Germany—					
Mansfeld	12,643	11,516	10,999	9,800	8,400
Other German	*1,220	*1,743	1,743	1,000	*600
Hungary	*1,000	*976	976	976	976
Italy	*1,600	*1,400	*1,480	*1,380	*1,140
Japan	*2,800	*2,800	*1,900	*1,900	*1,900
Mexico	489	401	333	*400	*400
Newfoundland—					
Betts Cove	1,053	1,500	1,718	*1,500	*1,500
Norway—					
Vigsnaes	2,340	2,300	2,350	2,040	2,000
Other Norwegian	*290	*290	290	386	412
Peru	395	440	615	*600	*600
Russia	*3,000	*3,000	*3,000	*3,081	3,081
Sweden	800	798	995	1,074	800
Spain and Portugal—					
Rio Tinto	20,472	17,389	16,666	16,215	13,751
Tharsis	*9,800	*9,000	*10,203	*9,151	*11,324
Mason & Barry	*8,000	*8,000	*8,170	6,603	4,692
Sevilla	2,026	1,885	1,340	1,705	1,360
Portugueza	2,357	1,700	1,410	1,000	770
Poderosa	*1,000	*800	*800	*800	*800
United States	52,080	39,300	30,882	25,010	23,350
Venezuela—					
New Quebrada	4,018	3,700	2,823	1,800	1,597
Totals	193,454	174,596	159,711	151,057	149,156

What promises partial relief from the disadvantage of costly transportation alluded to, is the practice now coming into vogue of concentrating the low grade copper ores, or reducing them to regulus at the mines, a plan that in this State is likely to be widely acted upon hereafter. It is probable, too, that we shall yet see a comprehensive system of reduction works established at some point on the Bay of San Francisco, whereat every class of copper ore can be economically and successfully treated, and a regular market be thus furnished for the product of our mines. The method here so often pursued of erecting small and imperfect works on the ground for handling only the richer portion of the ores is both expensive and wasteful. The secret of the success reached at Swansea, Wales, in treating copper ores, consists in securing great quantities of every class of ores, and through skillful selection so combining them that one class supplies the elements in which another is deficient. We have only to adopt and carefully carry out the methods practiced in these older countries to render copper mining a very prosperous industry in California.

THE PROBABLE FUTURE OF THE BUSINESS IN THIS STATE.

With some improvement made in the methods of reduction, transportation somewhat cheapened, and conditions otherwise more favorable now than aforetime, an increased output of copper ores may be looked for in California, our cupriferous resources being undoubtedly very considerable. Some of the richest deposits yet found in the State have remained unworked and but little developed, partly because mining for the precious metals has been with us the all-absorbing pursuit, and partly owing to the cost of transporting this class of ores to market, the Rodger's mine, in Hope Valley, lying in the eastern part of Amador County, being a case in point. The ore here, a combination of sulphide, oxides, and carbonates, is very rich, and so attractive in appearance that it has been much sought after for cabinet specimens. Though discovered nearly thirty years ago the deposit has not yet been sufficiently exploited to determine its extent or value. So, also, the deposits in the Alta district, Del Norte County, though discovered many years ago and known to abound with ores of good grade have been almost wholly neglected; the fifteen miles of wagon transportation, over a rough country to Crescent City, having been the barrier to their earlier development.

TESTING AND ASSAYING COPPER ORES.

Copper ores are tested and assayed by the following methods: To simply ascertain if an ore, mineral, or substance contains copper, the simplest method is to place a small fragment on a clean piece of charcoal, and heat it strongly before the flame of a lamp urged by a blast from a common mouth blowpipe. This may be continued for some minutes. Then a few drops of hydrochloric acid is taken on a glass rod and placed on the assay. This may be repeated several times until the fragment of ore is wet with the acid. A fine pointed blowpipe flame is then directed on the assay, and if the flame is turned distinctly blue, copper is present. This experiment is best made in the dark. The ores of copper when pulverized and heated before the blowpipe with fluxes (carbonate of soda and borax) yield generally a globule of copper, which may be recognized as such by being hammered out thin and scraped with the point of a knife. If now examined by daylight under a microscope of moderate power there can be no mistake, especially after some experience obtained by practice.

To make an *assay* of ore for the copper it contains, a different treatment must be employed. The ore is first to be finely pulverized and sifted. A portion is then weighed out with accuracy—say five grams. This is placed in a clean small porcelain evaporating dish, and wet with concentrated sulphuric acid, after which it must be stirred with a glass rod, or strip of glass, which must not be removed during the operation. The dish is then set either out of doors or under a chimney having a strong draft, when a few drops of nitric acid is poured upon it. Intense action generally takes place with the evolution of orange fumes of nitrous acid, the inhaling of which should be carefully avoided. When the action partially ceases more acid is added at intervals, until a green liquid is obtained, containing copper in solution. During this operation the mixture should be frequently stirred with the glass rod. Gentle heat is then applied, with frequent stirring on a sand bath, until the contents of the dish are reduced nearly to a state of dryness, great care being taken to prevent loss by spurting. After the mass has been allowed to cool, sulphuric acid and water are added, and the whole poured on a paper filter. Carefully washing the rod and dish with water, this is also poured on the filter. The contents of the latter are washed with water, until the dropping filtrate has no taste. When the operation is finished the clear green liquid is poured into a capacious and clean beaker glass, and gently heated. A strip of clean Russian sheet iron is prepared and placed in the beaker. It should be at least two inches wide, and long enough to project above the liquid, so that it may be handled. In a short time all the copper will be precipitated, which is shown when no more falls, when the adhering copper is shaken from the iron slip. The iron is then removed, and the liquid decanted from the precipitated copper, leaving enough to cover the precipitate. Boiling water is then poured on, and in a few minutes decanted. This is repeated several times. The last time the whole is poured on a weighed filter, and washed several times with boiling water, then with alcohol, and lastly with ether. The filter is then removed from the tunnel, and quickly dried on a water bath and weighed. When the weight of the filter is deducted, and the remainder multiplied by twenty, the result will be the percentage of copper in the ore. This assay is very accurate, if carefully performed, but unreliable otherwise. The assay by the volumetric method and by fire may be learned from chemical text-books and works on assaying; but the above will answer the purposes of the prospector sufficiently well.

SULPHATE OF COPPER.

Crystallized sulphate of copper has the following composition:

Oxide of copper	31.86=copper, 25.3 per cent.
Sulphuric acid	32.07
Water	36.07
	100.00

The crystals should be blue, without any green shade. They crystallize in the rhomboidal system. Sulphate of copper dissolves in 4 parts of cold, or 2 parts of boiling water. The following table will show the amount, in per cents, that a solution of sulphate of copper contains of the crystals at 75° F. It must be assumed that nothing is held in solution but sulphate of copper:

At 10° Beaumé	7 per cent.
At 12° Beaumé	8 per cent.
At 15° Beaumé	10 per cent.
At 18° Beaumé	12 per cent.
At 21° Beaumé	15 per cent.
At 24° Beaumé	17 per cent.
At 27° Beaumé	19 per cent.
At 30° Beaumé	20 per cent.

The usual impurity of sulphate of copper is sulphate of iron, with which it forms a double salt that cannot be separated by crystallization. This may be detected by adding to a solution of the crystals, first, a drop of pure nitric acid, and then sufficient ammonia to form a clear deep blue solution; if the sulphate of copper is pure, there will be no residue of floating particles. If these are seen, of a flaky brown appearance, it is a proof that the sulphate is impure and contains iron. The quantity will give an idea as to the extent of this impurity. This iron can be removed and pure sulphate of copper obtained. This is effected by heating the crystals to dull redness and redissolving, which leaves the sulphate of copper nearly pure; as this is a costly operation it is seldom resorted to unless the copper is very impure. Commercial sulphate is supposed to contain some sulphate of iron.

Sulphate of copper is made on a large scale in several different ways.

If the ore is a sulphide, which may be known by roasting a powdered sample in a shovel, when the smell of burnt sulphur may with certainty be recognized, the ore must be roasted.

If no sulphuric acid is to be used the roasting must be done in a reverberatory furnace, with free access of air, and the roasting *must not be pushed too far*. The exact point can only be learned by practice; it will be found to require considerable skill. When the exact point is reached the ore is drawn out and spread on an inclined surface, and sprinkled with water. The incline is so arranged that the water may be collected and again returned to the roasted ore. After a time the wash water becomes blue, and may be evaporated to crystallization. Sulphate of copper so obtained generally contains much sulphate of iron, which must be separated as before described.

If it is intended to use sulphur the roasting must be pushed further. The roasted ore is then boiled in sulphuric acid and water, and the solution evaporated to 30° Beaumé, and left to crystallize. This is best done in copper pans, but may be done in lead-lined tanks.

Some ores, such as oxides or carbonates, may be decomposed economically by boiling in sulphur without roasting. The following experiment will determine if the ore is of such a nature. Boil, in a porcelain dish, a small quantity of the ore with sulphuric acid, diluted with one half water. If a deep blue solution is obtained the operation may be repeated on a weighed portion, after which the solution may be evaporated to dryness and weighed. And thus an idea can be gained of the quantity of sulphate the ore will yield. Say the weight of the ore taken was 100 grams, and the sulphate obtained was 76 grams, then $76+20=1520$ in pounds that a ton of the ore would yield by such treatment on a large scale, if a fair sample has been operated on. Large quantities of sulphate copper are made from old copper plates taken from ships. The same plan may be pursued to work plates from sluices and batteries and recover the gold they contain. There are several ways of working these plates.

The copper sheets can be dissolved in concentrated sulphuric acid by boiling in a cast-iron pot which strong acid does not attack. The gold, if any, will be found in the bottom of the pot as a black powder, which may be washed and melted. The copper solution can be run into lead pans concentrated to 30°, crystallized, and the mother liquid evaporated. Sometimes copper plates are heated red hot in a reverberatory furnace, drawn out when hot and hammered to remove the oxide; this being repeated until the whole sheet is oxidized. Steam is sometimes blown in to assist the process. The oxide is easily dissolved in diluted sulphuric acid. Sometimes sulphur is thrown in and the furnace closed and the sulphuret decomposed by boiling in sulphuric acid. When the sulphate is dissolved, the plates are returned to the furnace, more sulphur added, and the operation repeated until the sheets are all dissolved.

Another method is to make a succession of lead-lined tanks, one above the other. These are loosely filled with sheets of copper; they are all furnished with perforated bottoms; diluted sulphuric acid is pumped up into the upper one and showered over the copper from a rose sprinkler; this passes down through the other tanks and is again pumped up several times a day. The solution soon assumes a blue color, and gains strength. By this method the copper is in a short time dissolved; when the acid becomes saturated more must be added.

41. COPPERAS. Etym. *Cuprosa* (Lat.). Coquimbite, in part Hydrous Sulphate of Iron.

Sulphate of iron occurs in several localities in the State, and is generally the result of solfataric action, as at the Sulphur Bank in Lake County, where it is very abundant. No analysis has been made of it, so that its exact composition is unknown. Dr. Trask, in his report of 1854, fol. 56, says it is found in large quantities near the town of Santa Cruz; in such quantity that it could be extensively manufactured as an article of commerce. I formed the same opinion as to the sulphur bank before mentioned. Sulphate of iron is valuable as a disinfectant, as a source of sulphuric acid, and Venetian red. It is also used in dyeing, bleaching, the manufacture of ink, and in chemical operations. The estimated production of sulphate of iron in the United States in 1882, was 15,000,000 pounds. The operation of making it from the crude material is easy. It is simply required to leach it out of the earth, and crystallize it in suitable tanks. It has been mentioned elsewhere that large quantities of this material were wasted in the production of metallic copper from the mutual exchange of elements, when metallic iron is placed in a solution of sulphate of copper, at the extensive works in Calaveras County. In other places sulphate of iron could also be obtained from the refuse of the chlorination treatment of sulphides from the gold mines in the State. A sample of saturated solution of sulphate of iron was sent to the Mining Bureau recently, leached from ground sulphides that the party who sent it states could be obtained at the rate of seventy gallons per ton. This is only another evidence of the enormous waste that is permitted in the metallurgy of ores in California.

Copper—Blue Carbonate—see Azurite.

Copper Glance—see Chalcosite.

Copper—Green Carbonate—see Malachite.

42. CORUNDUM. Etym. *Kurand* (Hindoo).

This mineral is composed of alumina. When pure it is sapphire, ruby, oriental topaz, oriental emerald, oriental amethyst, etc. When combined with manganese and other impurities it becomes emery, very valuable for the manufacture of emery wheels, and cloth, and whetstones for grinding, and for grinding and polishing in a powdered state. According to Baron Richthoven it is found in the drift in the San Francisquito Pass, Los Angeles County, California.

43. CUBAN. Etym. *Cuba.*

This mineral sulphate of copper and iron resembles chalcopyrite in composition. It has a brownish appearance, and it is said to be found on Santa Rosa Creek, San Luis Obispo County. One mass weighed 1,000 pounds. I consider this statement as doubtful.

44. CUPRITE. Etym. *Cuprum*, copper (Latin). Red Oxide of Copper.

Copper	88.8
Oxygen	11.2
	100.0

H=3.5—4, sp. gr.=5.85—6.15. Color red, almost vermilion red in some specimens, in others of a darker shade. Sometimes earthy and of brick-red color (tile ore); when mixed with oxide of iron nearly black. B. B. on ch. easily reduced to a globule of copper; wet with hydrochloric acid colors R. F. blue. Cuprite is rather a common mineral in California. It is found with native copper in the Pearl copper mine, Del Norte County; near St. Helena, Napa County, in masses of considerable size, with native copper; with malachite and calcite at the San Emedio Ranch, Coast Range; at the May Flower mine, Mineral King district, Tulare County; in microscopic crystals in the Peck mine, Copper Hill, Shasta County; on the borders of Mono Lake, Mono County; at the Candace mine, Colusa County; and near Lincoln, Placer County.

(3369) is from the Reward mine, Plumas County.
(3714) is from the Mammoth copper mine, Mono County.
(4456) with native copper, from Trinity County.
(4653) with native copper, from Meadow Lake, Nevada County.
(4746) with azurite and malachite, Kerrick mine, Mono County.
(5158) in microscopic crystals, with chrysocolla and cerargyrite, from Lundy, Mono County.

And at numerous localities in the Inyo Mountains, Mono and Inyo Counties.

According to Blake, it occurs sparingly in thin crusts and sheets with the surface ores of the principal copper mines in Calaveras County, especially the Union and the Keystone; in Mariposa County, at La Victoire mine, with green and blue carbonates of copper; in Del Norte County, at the Evoca, Alta, and other mines, in very good cabinet specimens, the cavities being lined with crystal; in Plumas County, and in the upper parts of most of the copper veins of the State.

45. CUPROSCHEELITE.

This mineral is a tungstate of lime and copper, first discovered by Prof. J. D. Whitney in 1863, and described in the Proceedings of the California Academy of Sciences, vol. 3, fol. 287. It has been found massive, and in well defined crystals. Homogeneous, yellowish-green color. Luster, vitreous. H=5.5., sp. gr.=5.863. Streak, white. Anhydrous. Fusible; after heating turns purple. B. B. dissolves in borax to opaque white bead; dissolves in microcosmic salt with green color, both hot and cold. It is insoluble in water, hydrochloric acid, or aqua regia. Even after fusion with bisulphate of potash, a dense golden-yellow powder remains in either case. Fused with 1 part of nitrate of potash, 2 parts of carbonate of potash, and 2 parts of carbonate of soda, it becomes soluble; the portion insoluble in water being wholly soluble in hydrochloric acid. When first found it was supposed to be a mechanical mixture of scheelite with some copper mineral, but a close examination under the microscope shows it to be perfectly homogeneous. A large crystal was found in Kern County, which would hardly occur in a mechanical mixture of two minerals. The specimen described by Prof. Whitney was from Lower California, of which the following is an analysis:

Tungstic acid	79.69
Oxide of copper	6.77
Lime	10.95
Protoxide of iron	.31
Water	1.40
	99.12

It has since been found in the Green Monster copper mine, Kern County, about twelve miles east of White River Post Office. Cuproscheelite is generally found with black tourmaline. No. 3666, also from Kern County, has this mineral as an associate. As a source of tungstic acid it would be valuable if found in sufficient quantity.

46. DATOLITE, OR DATHOLITE. Etym. "*To Divide*" (Greek).

So named from the granular structure of certain varieties. It is a silicate of lime, containing from eighteen to twenty-two per cent of boracic acid, found in trappean rocks—gneiss, diorite, and serpentine. It is a probable source of boracic acid resulting from the decomposition of rocks.

This mineral has, as yet, been found at one locality only, but from the universal distribution of boracic acid in the State, it is likely to be found elsewhere. The locality (of the specimen No. 2190) is a mining tunnel near San Carlos, Inyo County. It occurs with grossularite in fine crystals, the datholite being the matrix in which the grossularite is imbedded. This mineral was first noticed by the late J. Lawrence Smith and an account of it published in the American Journal of Science a number of years ago.

47. DIALLOGITE. Etym. *doubtful* (Greek). Rhodochrosite, Carbonate of Manganese.

This mineral is represented in the State Museum by a single specimen, No. 3584, in beautiful pink crystals from the Colorado mine, No. 2, Monitor District, Alpine County.

48. DIAMOND.

The name diamond is a corruption of "adamas" or "adamant," derived from two Greek words, meaning "I conquer," referring to its excessive hardness. It is pure carbon crystallized. Chemically it does not differ from charcoal, and is also nearly identical in composition with graphite. It is the hardest of all known substances. Its specific gravity is 3.529 to 3.55. Diamonds are not always colorless, and this fact renders their determination difficult. They are sometimes tinged yellow, red, orange, green, brown, blue, rose-red, and often black. When the color is decided they are more valuable than when limpid. When light colored, they are said to be "off color." The fracture of the diamond is fourfold, parallel to the faces of the octahedron. The fragments are octahedral or tetrahedral. It strikes fire with steel, the surface is often rough or striated, sometimes covered with a scaly crust. The touch of the diamond is cold. When the cut gem is breathed upon the luster is lost for a moment, when defects are seen.

Sir David Brewster found cavities in the Kohinoor, and other large diamonds, with the microscope. Black diamonds he found to be opaque from a multitude of such cavities. One large diamond having a black spot in it was cut in two, and the defect was found to be vegetable mud inclosed in the crystal.

There is a peculiar appearance about a rough diamond which can hardly be described. No written description would convey to the reader a correct idea of what it is exactly like. It is easy to say that they possess a peculiar luster, like spermaceti, but who would feel certain of the identity of a diamond from such a description? Once seen, this peculiar luster becomes impressed on the mind. To educate the eye, models of rough diamonds are made at Amsterdam for the use of prospectors, and they are found extremely useful.

The diamond crystallizes in the isometric system. Sometimes crystals show the impression of other crystals upon their faces. The Indian diamonds are generally octahedral; those from Brazil dodecahedral. It has been found massive in Brazil. In this form it cuts glass, scratches quartz and topaz, has a specific gravity of 3.27 to 3.52, and is nearly pure carbon, being completely consumed in oxygen gas. It occurs in kidney-shaped, irregular masses, exterior generally black, sometimes resembling graphite, has a somewhat resinous luster, and sometimes takes very singular forms. The outer coating black and resinous interior crystalline, vitreous and lamellar, like the diamond. It has been used in powder to cut other diamonds. The diamond cutters call this variety "cheese stones."

Black diamonds are sometimes called "carbonate," or "carbonado." They are even harder than the crystallized stones. They are found in mammillary masses, sometimes 1,000 carats in weight.

The diamond is supposed to be of vegetable origin, and is believed, by those who have studied it carefully, to be produced by slow decomposition of vegetation or bituminous matters. It is generally colorless, but always transparent (except in case of the black diamond), and often found in rounded masses, occasionally in curious, irregular, concretionary forms, like chalcedony, or semi-opal. Generally the faces of the crystals are curved; sometimes they take a nearly spherical form, having forty-eight faces.

The diamond exhibits a beautiful play of colors in the direct rays of the sun or bright artificial light. To its luster has been given the name of "diamond," or "adamantine luster." Its refraction is simple, but it possesses this power in a higher degree than most other minerals of equal specific gravity. In consequence of its extreme hardness, it can only be cut by its own powder. The common saying "diamond cut diamond," is exceedingly expressive. When rubbed it becomes positively electrical, even before being cut, in which it differs from all other gems. When, after exposure to direct sunlight, it is suddenly placed in darkness, it shows phosphorescence, and the evolution of light continues for some time. It is not acted upon by any acid or alkali, but it may be consumed and completely oxidized to carbonic acid at a high heat in the atmosphere. It is so difficult to burn that the ordinary blowpipe flame has no effect upon it. It may be heated to whiteness in a closed crucible without change, but it begins to burn in a muffle at the melting point of silver. At a high heat, with nitrate of potash, it is rapidly decomposed. A diamond may be burned away on a piece of platinum in the flame of a powerful blast blowpipe.

Newton first suggested the probability of the diamond being combustible. He was led to this opinion by observing its power of refracting light so strongly. It was in 1675 that he advanced this theory. In 1694, the members of the Academy of Florence succeeded by means of powerful lenses in consuming diamonds. Lavoisier and others proved that the diamond was not evaporated, as supposed by the Academicians, but was actually burned. Lavoisier found by his experiment that if air was excluded, no decomposition took place. He burned diamonds in close vessels with powerful burning glasses, and found that carbonic acid was produced, and discovered and announced the striking similarity between their nature and that of charcoal.

Sir George McKenzie found that they could be consumed in a common muffle. In 1797, Mr. Tennant made a decisive experiment, by placing a diamond, the weight of which was noted, into a tube of gold with nitrate of potash. The tube was subjected to great heat, which was maintained some time. The diamond was oxidized at the expense of the niter. The carbonic acid evolved was conducted into lime water, and the precipitated carbonate of lime weighed. It was found to be equivalent to carbon, equal to the weight of the diamond consumed, proving it to be pure carbon.

The diamond may be burned in oxygen by suspending it in a glass globe filled with that gas. The stone is held suspended in a coil of fine platinum wire, which is made red hot by passing a current of electricity through it. The diamond soon begins to burn, and is wholly consumed. Lime water or baryta water is then shaken in the globe, when a precipitate of carbonate of lime or baryta is formed, which dissolves with effervescence in dilute acids.

The diamond can be fused by the action of a powerful galvanic battery. Experiments made with a view to prove this resulted in the fusion of six small diamonds in seven and one half minutes. On exposure to the greatest heat, they first changed to charcoal, then to graphite, after which they fused into globules. These experiments led to the conclusion that the diamond is not produced by the action of intense heat on vegetable or organic substances, which is a favorite theory. The diamond is a non-conductor of electricity. After a great fire in Hamburg, diamonds were sold for small sums, which had turned black, but, upon being repolished, they became again as brilliant as ever.

With the information given in this paper, and the specimen in the State Museum, miners and prospectors should be able to recognize diamonds if they find them in their claims, and as it is more than possible that gems of great value may be discovered, it will be well to observe the following rules in dealing with such discoveries:

When a stone supposed to be a diamond is found, do not attempt to test its hardness, even by gentle blows with a hammer. To properly do this, a small emery wheel may be used. Any miner can send to San Francisco, or elsewhere, and have such a wheel sent to him by mail. A suitable size would be one about two inches in diameter and one quarter of an inch in thickness. Such wheels are used by dentists and jewelers, and may be obtained from dealers in such goods. The wheel may be laid on the table flat, and the stone rubbed on it. If the stone is worn away in the least degree, it is not a diamond. By this simple test, the question may be answered in numerous cases. Should the stone resist the emery wheel, it *may* be a diamond; but this is not certain, for other stones will also stand this test.

The diamond is generally, if not invariably, found associated with a peculiar granular laminated quartz rock or sandstone, to which the name of itacolumite has been given. According to Dana it owes its lamination to a little talc or mica. This rock is found in Brazil, in the Urals, and in North Carolina and Georgia. A specimen from the latter locality may be seen in the State Museum—catalogue number 1371. It is five inches long, and so flexible that it may be bent a quarter of an inch without breaking. As far as I know, this rock has not been found in California. Professor Whitney does not mention it in either his volume on general geology or his auriferous gravels. I have looked for it at the localities of the diamond that I have visited, and have made many inquiries, but as yet without success.

Diamonds are found in Brazil, in beds of gravelly conglomerate called "cascalho," frequently cemented by oxide of iron, and from description, resembling some of the cemented gravels so common in the hydraulic and drift mines of California. In such an iron cemented formation a negro slave in Brazil found a bed or cluster of diamonds—probably in place—which sold for $1,500,000. Shortly after the discovery of the African diamond fields, Mr. J. H. Reily, who returned from thence, brought to California samples of the gravels associated with diamonds, which are probably preserved in some collection in the State.

Platinum, gold, rutile, zircon, quartz, feldspar, brookite, diaspore, magnetite, and yttria minerals are almost always the associates of the diamond. Some platinum has been found in Georgia and North Carolina, where a few diamonds have also been found.

Humboldt, in one of his works ("Essay on the Bearing of Rocks"), calls attention to the fact that gold, platinum, and diamonds are associates in various parts of the globe—in some places gold, platinum, and palladium; in others, gold, platinum, and diamonds. In the River Aboite, in Brazil, diamonds are found with platinum; near Tejuca, with platinum and gold. These facts awakened in him the strongest hope of finding diamonds in the Ural, where the association of these metals is known to exist. When he arrived at any of the works, he caused the gold sands to be examined microscopically, and if gold and platinum were found, he directed the workmen to look carefully for diamonds. These examinations led to the discovery of microscopic crystals, previously unknown in the gold sands of the Ural—such crystals, as in Brazil, occurred with gold, platinum, and diamonds.

The truth of Humboldt's theory as to the existence of diamonds in the gold sands of the Ural was proved by the subsequent discovery of a valuable stone by Paul Popoff, a boy of fourteen years, to whom belongs the honor. It was at first supposed to be a topaz, but a young Freiberg student, a Mr. Schmidt, who had the necessary instruments to test the hardness and specific gravity, identified it as a true diamond. Two others were soon afterwards found, the third being larger than both the others, followed by systematic search, which has since produced many valuable stones.

Diamonds found in river beds are generally in amorphous, while those found embedded in the formations peculiar to their locality are covered with an earthy pale gray, yellow, or rose-red coating. The texture of the diamond is lamellar.

The early history of the diamond is obscure. There seem to have been stones of quite different nature known to the ancients as "adamas." Pliny says: "Adamas is a mineral which for a long time was known to kings only, and to but few of them. The ancients supposed that adamas was only to be discovered in the mines of Æthiopia, between the temple of Mercury and the Island of Meroe, and they have informed us that it was never larger than a cucumber, or differed at all from it in color."

It is very certain that Pliny knew but little of the matter, for he describes six varieties, all of which, according to his description, possessed properties not found in the diamond, but he becomes absurd when he says that the diamond, "which resists every force of nature, is made to yield before the blood of a he goat." To those who wish to verify this reaction he gives the following advice: "The blood, however, must be warm; the stone, too, must be well steeped in it, and then subjected to repeated blows."

Allusions met with in their ancient mythology lead to the supposition that the Hindoos were in possession of gems and held them in high estimation.

According to Jewish history as set forth in the Bible, the diamond was one of the twelve gems set in the breastplate of the high priest. But to my surprise I find that Josephus denies this indirectly. As the discrepancy is remarkable, I have given both authorities:

Bible.		Josephus.	
1	Sardius	1	Sardonyx
2	Topaz	2	Topaz
3	Carbuncle	3	Emerald
4	Emerald	4	Carbuncle
5	Sapphire	5	Jasper
6	Diamond	6	Sapphire
7	Ligure	7	Ligure
8	Agate	8	Amethyst
9	Amethyst	9	Agate
10	Beryl	10	*Chrysolite*
11	Onyx	11	Onyx
12	Jasper	12	Beryl

It will be seen that in the list given by Josephus that the arrangement is different, and that the chrysolite replaces the diamond. According to the Bible, the diamond was one of the precious stones worn by the king of Tyre.

History shows that the ancients attributed great medicinal powers to gems. They were worn also as a protection against all forms of evil, some in a vague general way, while others were regarded as antagonistic to special diseases or accidents. Pliny claims for the diamond that it will "overcome and neutralize poisons, dispel delirium, and banish groundless perturbations of mind." Less than a century ago diamonds were borrowed from rich families to act as a cure for certain diseases. It is said that to prevent them being swallowed by the patient they were secured by a string when placed in the mouth.

Plato and Pythagoras must have known something of gems and crystals, as they have beautifully written how "Nature, in the dark recesses of the earth, occupies her time in working out geometrical problems."

It is a curious historical fact that when, during the French revolution, the diamonds of the rich were given to the people, it was found that many of them were imitation.

Until quite recently the chemical composition of the diamond was unknown, nor could it be cut by any means known. It was worn as found, and was consequently inferior in appearance to those we see in our day. As soon as its chemical nature was discovered, attempts were made to produce it artificially in the laboratory, but up to the present day with only partial success.

The first diamonds came from India. The famous mines of Golconda are situated between Hydrabad and Masulipatam. Other localities in India have produced large quantities. It is said that Sultan Mahmoud, when he died, left 400 pounds of diamonds. These diamond fields are now exhausted and seldom produce any stones of value.

Diamonds were discovered in Brazil in 1728. They had always been thrown aside as useless in gold washing, until one who had seen this gem in the rough state quietly collected a large quantity of them, from the sale of which, in Portugal, he realized a fortune. They are found in an alluvial soil, in the district of Cerro di Fria, Minas Geraes, San Paulo, and in other localities. Those Californians who have visited Rio Janeiro will remember the gorgeous display of diamonds in the shop windows—the product of these mines. It is said that Brazil has produced over two tons of diamonds. When the Brazilian diamond fields were opened, it was not believed in England; but it was thought that Indian diamonds had been sent to Brazil, and from thence to England. The mines of Borneo have produced but few large diamonds, but great quantities of small ones. The amount of annual production credited to that island is 2,000 carats=$1.\frac{143}{1000}+$ lbs. avoirdupois. There have been two panics in the price of diamonds; the first when it was known that Brazil was producing large quantities of this gem, and the other at the time of the French revolution. At these periods the prices of diamonds fluctuated in the strangest manner.

The discovery of unusually large deposits of diamonds in South Africa in the year 1867 caused considerable commotion in the diamond trade. In 1880 the gross weight of diamonds that passed through the Post Office at Kimberley was 1,440 pounds and 12 ounces avoirdupois, the estimated value of which was $16,000,000. At the end of 1880, 22,000 blacks and 1,700 white men were employed in the diamond fields of South Africa; 250 men were engaged in diamond mining on the Vaal River the same year.

From Kimberley and Old De Beer's mines alone diamonds to the amount of 3,000,000 carats are annually raised. The other mines produced 300,000 carats in 1880.

According to Professor Tennant, ten per cent of the Cape diamonds are first class, fifteen per cent second class, twenty per cent of the third; the remainder being of the quality known as *bort*, and are useful only to cut other diamonds, and for glaziers' diamonds, rock drills, etc.

The most valuable diamond found in the United States was discovered in 1856 on the banks of the James River, opposite Richmond, Virginia; its weight was 23.7 carats (ninety-nine grains).

REMARKABLE DIAMONDS.

A diamond over ten carats in weight is called a "princely" diamond; only one in about 10,000 can lay claim to this distinction. There are eight diamonds which, being of unusual size and splendor, are called "sovereigns." All of them are more than one hundred carats in weight. The following is a list of the sovereigns, and the most celebrated of the princely diamonds known:

No.	Name.	Carats.	No.	Name.	Carats.
	Sovereigns.			*Princely Diamonds.*	
1	Braganza*	1880	9	Piggott	$82\frac{1}{4}$
2	Mattam	367	10	Shah	86
3	Great Mogul	$297\frac{3}{16}$	11	Nassak	$78\frac{3}{8}$
4	Orloff	$194\frac{1}{4}$	12	Bryce Wright	$66\frac{1}{2}$
5	Florentine, or Toscanor	$139\frac{1}{2}$	13	Sancy	$53\frac{1}{2}$
6	Regent, or Pitt	$136\frac{3}{4}$	14	Eugene	51
7	Star of the South	125	15	Hope (blue)	$44\frac{1}{2}$
8	Kohinoor	$106\frac{1}{16}$	16	Pasha of Egypt	40
			17	Cumberland	32
			18	Polar Star	-------

* Thought to be a Topaz.

There are others which could be mentioned, but the above table includes all those of special interest. A green diamond at Dresden weighs forty-eight and a half carats, and is said to possess remarkable brilliancy and beauty. The celebrated French blue diamond was lost in the revolution and never found.

Diamond cutting not only requires great skill and judgment, but also the outlay of considerable capital. The largest establishments for this branch of industry are in Amsterdam. In the year 1872 I visited the works of M. & E. Coster, in that city, and saw the whole operation. The building is a large brick structure, every part of which is devoted to some branch of the trade. A beautiful and powerful engine in the basement drives the machinery. Vertical shafts pass up to the top of the building, and from these the grinding discs are geared.

I was first shown the room where the diamonds are kept for safety, and had the opportunity of seeing some fine stones. From this room I was shown to another where the diamonds are split. This is a curious and delicate operation. Only workmen of great experience are allowed to attempt this work.

The rough diamond is taken up by one of the workmen in this room, who studies it carefully, calculates mentally what parts can be removed without detracting from the value of the stone, keeping in mind the rule, that the value of a rough diamond is only that of the largest doubly truncated perfect octahedron that it will make. All excess must be removed. It is a great advantage to split off fragments, for the double reason that the larger fragments may be cut with profit into small stones, to set around opals or pearls, and because it is a great economy of time, as the grinding down of the stone is a slow and tedious operation. It sometimes becomes necessary to remove flaws by this operation.

The workman is well aware of the fact I have already stated, that the cleavage of the diamond is fourfold, and takes of it every advantage. It is astonishing to witness the skill with which the operation is performed. A workman cements the stone to a piece of compact wood by means of strong cement, leaving the portion to be removed exposed. To this end he fashions the cement with his fingers, while still soft, then with a fragment of another diamond he makes a deep scratch along the line of cleavage. Then, after wrapping the stone in loose folds of cloth, he applies a steel rule or knife, and with a gentle and skillful blow with a light rod of steel, he breaks off the portion he wishes to remove with unerring certainty.

From the hands of this workman the stone passes to another in a second room, who continues the operation by cementing it again to the end of a stick, and taking another diamond of equal size, also cemented in the same manner to a stick, he rubs the two together until he produces the proper facets on each—each grinding the other down. The workman to whom this operation is intrusted wears heavy leather gloves. The powder resulting from the abrasion is carefully collected in a box, in which oil is kept, which collects the dust, and prevents it from being blown away. When sufficient has collected, the oil is burned away, leaving a gray powder called "bort," which is more finely powdered, and used to polish other diamonds. During the operation of grinding, the workman frequently touches the stone to his tongue, to see how the operation progresses; first, however, removing any adhering diamond dust with a camel's hair brush. This work does not form all the facets of a perfect stone.

The next and last operation is that of polishing the rough cut stone, and of cutting away some of the edges, producing a new set of facets, due to a perfectly cut brilliant.

The polishing is done on discs of iron or steel. These wheels are about three feet in diameter, and rotate horizontally. They move with great velocity, making two thousand revolutions in a minute. They are so true, and run so smoothly, that at first glance they seem like stationary tables, sustained by the vertical shafts. It requires some skill and labor to prepare the surface of these discs to render them suitable for receiving the diamond powder. Stones of varying fineness are used in such a manner as to leave striæ on the surface, something like that of the burr millstone, but very much finer. A mixture of diamond dust and olive oil is then placed on the face of the disc, which is called a "skaif." The workman then takes a brass tripod, of which one arm is longer than the others; in the end of this longer part there is a socket, which he fills with melted solder, into which, as it cools, he imbeds the stone, leaving the face only exposed which he wishes to polish. When the solder is perfectly cold and hard, he turns the stone down on the revolving plate, allowing the shorter arms to act as a claw to hold against the friction of the wheel.

He then puts weights on the end of the tripod above the stone. These are heavy or light, as the face is large or small.

The Amsterdam establishment employs from five hundred to six hundred persons. An establishment for diamond cutting has lately been started in New York, under the name of the New York Diamond Company. For many years diamonds have been cut and polished in Boston, and quite recently the English have turned their attention to the art in which they once excelled.

It requires practice to judge of the diamond in its rough state. A rough diamond of the first water would be hardly recognized by the uneducated eye as a valuable gem. In describing the diamond, many of its characteristics are visible only in its cut state. Half the stone is sometimes cut away before a perfect gem can be produced. The diamond washers of Brazil rub the stones together and produce a peculiar grating sound, by which they claim to judge of their value.

There are three modes of cutting the diamond; the rose, the brilliant, and the cabochon. The shape of the rough stone, and the taste or want of taste of the owner, determines which style shall be adopted. The art of cutting diamonds by their own powder originated with Louis Berghen, of Bruges, in the year 1476. At first the style was a flat table, with facets on the edges. The brilliant was invented during the reign of Louis XII. Cardinal Mazarin is said to have been the first who had diamonds cut in that form.

The cutting of the brilliant is governed by certain rigid rules, the slightest deviation from which produces an imperfect gem. David Jeffries, who published a treatise on diamonds and pearls in London in 1750, a copy of which may be found in the library of the State Mining Bureau, gives the rules in detail, illustrated by diagrams. The work also gives tables for valuing diamonds from one to one hundred carats, increasing by eighths of carats.

The stone is first reduced to a perfect octahedron, in which all the axes are equal. Setting one axis vertical, he divides it into eighteen imaginary equal parts. The edges at which the pyramids meet is called the "girdle." The upper part of the octahedron is cut off at the fifth division from the top and parallel to the girdle, forming the face, which is called the "table." The bottom part of the stone is then cut off at the first division, leaving a small face called the "collet;" the remainder is then a perfect square brilliant. The edges and solid angles are then cut into a number of facets and highly polished, and the brilliant is finished.

Sometimes to make a diamond appear larger the angle of the crystal is made greater than ninety degrees. Such a stone, wanting in depth, is deficient in brilliancy, although appearing larger than a perfectly proportioned stone. Such diamonds are called "spread brilliants." In other cases, for certain reasons, the angle is less than ninety degrees. The table is then smaller than it should be, and is unsatisfactory to the educated eye. Jeffries' tables for valuing stones is used as follows: Suppose the reader has a diamond which weighs four and one eighth carats, and wishes to ascertain if it has been properly cut. With a pair of small calipers he takes the width of the diamond and compares it with the model of a brilliant of the same weight in the table. Then with the calipers he takes the thickness of the stone, from table to collet, and compares it with the bar below the model. Lastly, he measures the size of the collet; if the diamond is badly cut the defect will be seen at once. These tables are much used, and may be found in works on diamonds and precious stones.

Diamonds are valued according to weight, purity of color, freedom from defects, etc. Much depends also on the state of the country where they are for sale. When times are prosperous and money plenty, they will find a readier sale than when the reverse is the case. There is no rule which gives the absolute value of first-class diamonds. But the trade is governed to a great extent by the formula devised by Jeffries, to whose work I have before alluded. His tables assume that diamonds increase in value proportionally to their increase in size. At the time his tables were calculated it was assumed that rough diamonds, both good and bad, averaged ten dollars (two pounds sterling) per carat. (One carat equals four grains.) To ascertain the value of any rough diamond he multiplied the square of its weight by the value of one carat. Thus, if a rough diamond weighed five carats, its weight would be 5×5×\$10=\$250.

A cut stone was calculated differently. It was taken for granted that a rough diamond loses half its weight in cutting, therefore the calculation was made on the value of a rough stone of double the weight; for example: for a cut stone of five carats, 10×10×\$10=\$1,000, and to this price was added the cost of cutting. The best glazier's diamonds are worth fifty dollars per carat, but few being fitted for that purpose.

The value of fine diamonds has largely increased since Jeffries' time, 1750, and in 1865 a diamond of five carats was worth in London £350, or \$1,750, reckoning the pound at five dollars. The same authority from which I take this valuation says that the stone must be free from the faintest tinge of color, from any flaws, specks, marks, or fissures of any sort, must be bright and lively, and free from what is technically called "milk" or "salt." The stone must also be cut in perfect proportion, according to the rules before given. This author also says that it is impossible to calculate the value of a stone above five carats, as the price then depends wholly upon supply and demand. When a diamond has a decided color it is called a fancy stone, and will bring a very high price.

Unfortunately, the temptation to produce large-surfaced stones at the expense of the rules of the true proportion is so great that perfectly cut stones are seldom seen.

The existence of diamonds in California was early known. In the Annual of Scientific Discovery for 1850, in an article quoted from Silliman's Journal, may be found a statement to the effect that the Rev. Mr. Lyman, formerly from New England, saw a crystal in California of a light straw color, having the usual convex faces, and about the size of a small pea. He saw the crystal but for a few minutes, and had no opportunity for close examination, but the appearance and form left little doubt that it was a true diamond. From that time to the present, diamonds have been occasionally found in the State.

Mr. W. A. Goodyear is quoted in Whitney's "Auriferous Gravels of the Sierra Nevada of California" as follows: "He saw a diamond in the possession of Mrs. Olmstead, at Dirty Flat, near Placerville, El Dorado County, which measured nine thirty-seconds of an inch maximum diameter, and weighed one and a quarter carats—$5\frac{61}{100}$ grains. It was found by Mr. Olmstead in cleaning up the sluices of the Cruson tunnel, Dirty Flat." The same stone is mentioned in Mr. Carpender's letter.

At the McConnell & Reed claim, on the south side of Webber Hill, a diamond the size of a small white bean was found. This diamond was discovered a few feet above the bedrock. Mr. McConnell thinks on a previous occasion he had thrown away a diamond as large as the end of his thumb, in ignorance of its true character. Two other diamonds were found in another claim, also on the south side of Webber Hill.

Three or four diamonds were found near White Rock. Mr. Goodyear purchased a crystal of Mr. Thomas Potts. It weighed half a carat—two grains; had a slight yellowish tinge, and was found in washing the gravel which came from a tunnel driven into White Rock. (See Mr. Carpender's letter.) Near the same locality three diamonds were found in gravel by the Wood Brothers, in 1867. The largest was valued by a San Francisco dealer at fifty dollars. The same authority gives the following localities of California diamonds: Jackass Gulch, near Volcano, Amador County; Indian Gulch, Loafer Hill, near Fiddletown, Amador County; French Corral, Nevada County, one specimen weighing seven and one half grains.

Diamonds have been found at Volcano, in Amador County, in a peculiar volcanic formation, described by Professor Whitney as "ashes and pumice cemented and stratified by water." The crystals had the form of the icositetrahedron, with faces curved in the manner peculiar to the diamond.

A formation occurs at Cherokee, Butte County, above the bedrock, which has the appearance of being the same volcanic mud to which I have before alluded, and somewhat resembling the deposit at Volcano, which I have seen and examined. Strong evidence that the so called white lava was not an igneous flow, and that it was at one time soft and plastic, is shown by the leaf impressions (Museum specimen No. 4219) presented by Dr. William Jones, and obtained two miles from San Andreas, Calaveras County. If the "lava" had been hot, it would have burned the leaves before they could have made any impression, and if the formation had been at all indurated the leaves could not have imbedded themselves, as shown in the specimen. With all our investigation and theories, we have much to learn concerning the auriferous gravels of California, their interesting mineral associates, and the geology of their deposition and occurrence.

Knowing that diamonds had been found at or near Placerville, and not having time to visit the locality, I addressed a letter to Mr. A. J. Lowry, Postmaster at Placerville, asking information, and in due time received the following reply:

PLACERVILLE, September 12, 1882.

Henry G. Hanks, State Mineralogist:

DEAR SIR: Your letter of August nineteenth, to Postmaster Lowry, of this place, asking for information as to the finding of diamonds near Placerville, has been handed to me, with the request that I answer it.

In 1871, Mr. W. A. Goodyear, Assistant State Geologist, while examining the deposits of auriferous gravels in the ancient river bed, about three miles east of Placerville, found several specimens of itacolumite, and expressed the opinion that diamonds should be found in the gravels. I assisted him in searching for them, and we found several in the hands of the miners. Mr. Goodyear bought one of them as a geological specimen. None of the parties who had them knew what they were, but had kept them as curiosities. The gravel in the channel is capped with lava from 50 to 450 feet in depth. Of late years the gravel is worked by stamp gravel mills, and I know of instances where fragments of broken diamonds have been found in panning out the batteries.

I give you the names of the finders of several diamonds in this vicinity, namely:

Charles Reed, one.

Mr. Jeffreys, one.

Thomas Ward & Co., three—Two white; one yellow. One of these is now in the possession of Mr. Ashcroft, of Oakland, who had it cut in England.

Cruson & Olmstead, four—One of which Olmstead sold to Tucker of San Francisco. It measured nine thirty-seconds of an inch in diameter, was pure, and nearly round. I think he got about $300 for it.

Thomas Potts, one—Which he sold to Mr. Goodyear for fifteen dollars. It was small, and flawed.

Jacob Lyon, one—Light straw colored, about the size of a medium-sized pea; also, several fragments obtained from the tailings of a gravel mill at the Lyon Mine.

A. Brooks, one—Small white.

F. Benfeldt, one—Small yellow, weighs two grains. It passed through a gravel mill.

The diamond mentioned in your letter as being "found by a lady in a dump at the mouth of a shaft," was probably the one found by Mrs. Henderson, in some tailings that had been washed for gold.

Yours, truly,

W. P. CARPENDER.

Mr. Melville Attwood was among the first to predict the discovery of diamonds in California. The following is an extract from a newspaper article written by him in 1854:

I am anxious to call attention to the chance of finding diamonds in this country, and the likelihood of their being overlooked. The rocks in which they occur are common in California. Itacolumite, a soft micaceous sandstone, always the associate of the diamond, is also found here. The gravel always found in the river washings so closely resembles the "cascalho," or "diamond gravel" of Brazil, that I think it very probable that if proper search was made diamonds would be found.

Mr. Attwood spent several years in the diamond districts of Brazil, and is familiar with the subject of which he wrote.

In August of this year I visited Cherokee, Butte County, specially to study that celebrated diamond locality. Mr. A. McDermott, druggist of Oroville, says that a diamond was sent to him in 1862 which was as large as a small pea. It was nearly globular and obscurely crystallized and of yellow color. He does not know the subsequent history of the stone, where it was found, or the owner's name.

At Cherokee, diamonds and zircons are found in cleaning up sluices and undercurrents. The first notice of diamonds at this locality dates from 1853, the largest discovered, which was two and a quarter carats (nine grains), is now in the possession of John More. There have been from fifty to sixty found, from first to last; some were rose colored, some yellow, others pure white, and all associated with zircons, platinum, iridium, magnetite, gold, and other minerals.

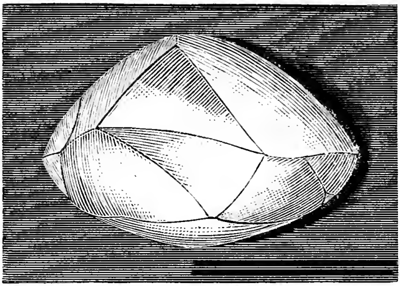
A similar association of metals occurs in the northern counties of California, especially in the region drained by the Trinity River, in the sands of which microscopic diamonds are actually found. The same may be said of the vicinity of Coos Bay, in Oregon, and along the banks of Smith River, in Del Norte County. Miners throughout this whole region, and in the hydraulic mines, should search carefully for diamonds, and should send anything they find, which is likely to be such, to the State Mineralogist for identification. Diamonds may be looked for in flumes, and in cleaning up sluices, with gold and platinum. An examination of the platinum sands of the Trinity River was made by Professor F. Woehler, of Gottingen, who found diamonds in them. After removing gold, platinum, chromic iron, silica, ruthenium, etc., by the usual methods, he examined the residue microscopically, and observed colorless, transparent grains, which he presumed to be diamonds. Subsequent combustion in oxygen and precipitation from solution of baryta, by the carbonic acid evolved, convinced him that the microscopic crystals were true diamonds. This fact is an extremely important one to the inhabitants of the Pacific Coast.

Platinum minerals have been found rather abundantly in Butte County. At St. Clair Flat, near Pence, they were collected in quantity in the early days of placer mining. They are found also at the Corbier mine, near Magalia (Dogtown). In 1861 a diamond was found one and a half miles northwest of Yankee Hill, Butte County, in cleaning up a placer mine. The stone was taken from the sluice with the gold, and sold to M. H. Wells, to whom I am indebted for this information. Mr. Wells presented the gem to John Bidwell, of Chico, who had it cut in Boston. It weighed one and a half carats—six grains. Mr. Bidwell gave the diamond to his wife, who now wears it on her finger. This was the only diamond found at the locality.

The State Museum is indebted to Mr. Louis Glass, Secretary of the Spring Valley Hydraulic Gold Company of Cherokee, for fine samples of platinum No. 4224 gold, No. 4225, and other interesting minerals from that locality.

A fine diamond from the Spring Valley mine, Cherokee, has also been presented to the State Museum No. 4033 by Mr. G. F. Williams, Superintendent, which has been placed in the Butte County case in the State Museum. Samples, also, of the gravels, and concentrations of black sands, platinum minerals, lava, bedrocks, etc., have been collected, and being now in process of arrangement, will soon be properly displayed. Samples of the interesting association of black sands described by me, and in Professor Silliman's papers, have been set aside for those who desire to make a special study of them, and to whom specimens will be sent on application. I had the pleasure of seeing a number of other diamonds from this locality during a recent visit. Mrs. Harris has a beautiful Cherokee rough diamond set in a ring. Mr. Harris, who was formerly Superintendent of the Spring Valley Hydraulic mine, has another, which has been cut. Of the two, I consider the natural crystal the most interesting and beautiful. Mrs. W. C. Hendricks, of Morris Ravine, near Oroville, also has a fine Cherokee diamond set in a ring.

A very interesting stone has lately been brought to my notice, which was found in July, 1883, by George Evans, on the surface of the ground at Rancheria, a small mining camp about four miles northwest of Volcano, Amador County. It weighs 255 milligrams. Its length is 0.315 inches; thickness, 0.215 inches. It is irregularly globular in form, all the faces being convex. Its form, magnified seven diameters, is shown in the cut. It is pale straw colored, very brilliant, and, as far as could be distinguished even under the microscope, is without a flaw.



Amador County Diamond, magnified seven diameters—drawn with camera lucida.

Miners are generally not familiar with the appearance of diamonds in the rough state, and would most likely mistake them, if found, for chalcedony or some similar mineral. If in crystal form, it would be to them a crystal only—interesting for the moment, to be soon thrown aside as useless. A case has been mentioned in which a beautiful crystal, supposed to be a diamond, being found in some placer mine in California, was put to the following test: It was placed on an anvil and struck a heavy blow with a sledge hammer, it being assumed that the diamond, being the hardest of known substances, could not be broken. This idea is more ancient than is generally supposed. The statement has been made by Pliny, but it is doubtful if he ever made the experiment himself. In speaking of Adamas, he says "it cannot be crushed, but would split hammers and anvils in the attempt." It is certain that this is a mistake. The diamond can be split on the edge of a knife, and even a light blow with a hammer might destroy the most costly gem.

49. DIATOMACEOUS EARTH.

A diatom is generally admitted to be a single-celled plant, bearing a singular relation to the animal and even to the mineral kingdom, being considered by some as belonging partly to the latter, and regarded as a vegetable crystal, differing only from minerals in having the power of locomotion and of multiplying by separation. Kutzing says: "In comparing the arguments which indicate the vegetable nature of the diatomaceæ with those which favor their animal nature, we are, of necessity, led to the latter opinion."

In connection with the idea that the diatom pertains somewhat to the mineral as well as the animal kingdom, it is a curious fact that if silica, deposited from fluoride of silicon, be crushed between plates of glass, and examined microscopically, with a medium power, markings may be seen on the outer surfaces of the vesicles which resemble those of the diatoms, especially pleurosigma and coscinodiscus. It is also remarkable that Dr. James Blake collected fifty species of living diatoms from a hot spring in Pueblo Valley, Nevada, the temperature of which was 163 F. Flint probably originates from diatoms, as does also the silica in certain rocks.

The name diatom is derived from a Greek word signifying being cut in two. Diatoms resemble the desmids, but differ in having an outer skeleton, or frustrule of silica. The frustrule of a diatom is a silicious box, always in two parts, one slipping over the other like a pill box, or with edges opposed. The thickness of a single diatom is, roughly, the sixth that of a human hair, and its weight is estimated at the 187-millionth part of a grain. Some varieties attach themselves to other bodies as the algæ, while others swim in the water free.

The study of the diatomaceæ, aside from the scientific interest, is very fascinating. Their extreme and varied beauty is a source of constant pleasure to the microscopist, and the question is often asked, why is so much beauty vailed from human sight?

The beauty of the diatoms consists in their color, their general form and sculpture, or natural markings, which characterize nearly all of them. These delicate markings are seen under the microscope to be processes, knobs, bosses, concavities, ribs, groovings, and lines, so minute that the highest powers made by the most skillful opticians are required to see them at all; even then, they can only be resolved when the apparatus is manipulated by the most skillful operators. The lines of certain diatoms have been measured and are used to test the magnifying and penetrating power of object glasses. A slide called a test plate has been prepared, on which twenty well known species are mounted, commencing with one on which the lines are comparatively coarse, and ending with one—*Amphipleura pellucida*—which has 130,000 lines to the linear inch. For the convenience of study, typical diatoms are mounted on a single glass slide, so arranged that reference can be made to a printed catalogue for the names, while in some cases the names of the species are micro-photographed on the slide.

The diatoms are placed on the plate by the aid of an ingenious device called a mechanical finger, by means of which the shells can be picked up singly and given the desired position. Moller's typen platte number one, has four groups, twenty-four lines in each, comprising about 500 individuals, of 395 distinct species and seventeen genera. The cost, with printed catalogue, is forty dollars. Some microscopists are so fond of the study of these minute forms, that they scarcely do any other work than to observe, collect, classify, and describe them.

When it is stated that the names of more than 4,000 distinct species of diatoms are given in a catalogue published by Frederick Habirshaw, of New York, each of which has some feature by which it may be distinguished; that this vast kingdom, so to speak, is invisible to the human eye, or nearly so; that when highly magnified many of the species are extremely beautiful, and all of them interesting, it is easy to understand why so much interest is taken in them the wide world over, and why every new discovery is heralded, and calls for samples come from the whole scientific world.

It is an established fact, strange as it may seem, that some of the greatest mountain chains, such as the Andes, and the very soil beneath our feet, is chiefly composed of the remains of animalcules, invisible to the eye; that is to say, the matter has been used by animated beings and returned again to the mineral kingdom, retaining the form which it assumed while a part of their minute bodies. Byron has written, with more truth than he probably realized, that "the dust we tread upon was once alive;" and the remark of Dr. Buckland is often quoted: "The remains of these minute animals have added more to the mass of minerals which compose the exterior crust of the globe than the bones of the elephants, hippopotami, and whales."

In the tertiary age, beds of diatomaceous or infusorial earth were deposited, consisting almost wholly of these microscopic organisms. The extent of some of these deposits is almost incredible, and is regarded as an evidence of the great age of the world. The Bohemian deposit in Europe is fourteen feet thick, and, by the estimation of Ehrenberg, contains 40,000,000,000 diatoms to the cubic inch.

Darwin observed in Patagonia, along the coast, for hundreds of miles in extent, a bed of tertiary sedimentary formation 800 feet in thickness, overlaid by a stratum of diatomaceous earth. At Bilin, in Austria, a bed of infusorial earth, fourteen feet thick, occurs. One merchant sells annually many hundred tons of it. The *Bergh mehl*, or mountain meal of Lapland and Norway, is from beds thirty feet in thickness. It must be remembered that these deposits extend over many thousands of square miles. Notwithstanding the astonishing fact that vast areas of the earth's surface are built of these minute forms, the true nature of these deposits was not known until 1837, when Ehrenberg published his celebrated work on that subject. The same deposition is taking place at the present time. In certain lakes in the United States and elsewhere, deposits several inches in thickness accumulate, composed wholly of the remains of recent diatoms. When thoroughly dried, a chalky powder is obtained, which, under the microscope, is easily recognized. Similar deposits have been made known by dredging the bottom of the sea.

According to Prof. Joseph Le Conte, of the California State University, in the deeper parts of Lake Tahoe, which sediments do not reach, the ooze is composed wholly of diatoms or infusorial shells.

Dusty showers of a grayish or red color are not unfrequent on the Atlantic and Indian Oceans, near the coast of Africa. Ehrenberg examined this dust, and found it to consist largely of diatoms. He estimated the quantity let fall during a dust shower in the year 1846, near Lyons, at 720,000 pounds, one eighth of which was diatomaceous, or 90,000 pounds, equal to forty-five tons. Diatomaceous earth may be distinguished from other formations of a similar appearance by its insolubility in acids, extreme lightness, power of absorbing liquids, and property of polishing metals. It is instantly recognized under the microscope in the hands of one who is familiar with its use. Diatomaceous earth has its uses as well as its scientific interest. It is largely consumed as a polishing powder, under the name of tripoli, from the locality which first gave it to commerce. It is known in California by the absurd name of *electro-silicon*, and at the East by a variety of trade names. It is a very convenient source of soluble silica, employed in the manufacture of silicate of soda or potash, also known as soluble glass. The manufacture of this compound is simplicity itself. Carbonate of soda, or potash, as the case may be, is dissolved in boiling water to saturation, in a capacious iron kettle, and fresh hydrate of lime added until all the carbonic acid is precipitated, and the alkali becomes caustic. Diatomaceous earth in a powdered state is then added as long as silica is dissolved, and the whole covered and allowed to cool. When the insoluble matters have settled, the clear liquid is drawn off and evaporated in a clean vessel to the required density.

Diatomaceous earth is also used in the manufacture of porcelain, and is a constituent of certain cements and artificial stones. At one time it was claimed to be a fertilizer, but this is thought to be a fallacy, although Ehrenberg states that the fertilizing power of the Nile mud is furnished by fossil infusoria. Slabs of diatomaceous earth absorb liquids with avidity, and are used in laboratories for drying crystals and filters. This property might be more generally utilized, if better known.

A convenient contrivance for lighting fires is a lump of diatomaceous earth with a handle of stout iron wire. It is dipped into a vessel of petroleum, placed in the stove or fireplace, and lighted with a match. It continues to burn safely for some time. It can be used again and again. No person, however, should make use of it who has not the common sense to carefully set away the vessel containing the coal oil before lighting the match.

Bricks that float in water are made of diatomaceous earth mixed with one twentieth part of clay and well burned. The art of making these floating bricks was well known in the time of Pliny, but was afterwards lost. It has recently been rediscovered. In the Italian department of the Paris Exposition of 1878, these bricks were exhibited, which attracted considerable attention. Floating bricks, made wholly of California material, may be seen in the State Museum.

Keiselghur, or "flint froth," of the Germans, from a deposit in Hanover, is extensively used in the manufacture of dynamite, giant powder, lithofracteur, and other explosives. Diatomaceous earth absorbs from three to four times its weight of nitro-glycerine, with the advantage over other absorbants of retaining the nitro-glycerine under greater pressure. Dynamite contains twenty-seven per cent and lithofracteur twenty-three per cent of diatomaceous earth. Before the keiselghur can be used, it is subjected to treatment to remove water, all organic matter, and coarse particles. It is first calcined in a succession of furnaces, crushed between rollers, and sifted. It is claimed that the diatomaceous earths of California are unfit for this purpose, but it is my opinion that they have not had a fair trial.

Diatomaceous earth is largely used in the manufacture of soap, to mechanically increase its detersive power. The Standard Company receive large quantities of it from the southern counties of the State. A polishing powder is sold in San Francisco under the name of "El Dorado Polish." It comes from Prospect Flat, three fourths of a mile from Smith's Flat, near Placerville. It is a diatomaceous earth. The deposit is called the "Silicon Lead."

Diatomaceous earth has been used with cement as a lining for fireproof safes, and in the fining of wines. It is not to be supposed that all the uses of this remarkable substance have been discovered; it remains for the intelligent inventor to search for new applications.

Diatomaceous earths are abundant in California, some of them being very interesting. The Monterey deposit has long been known to the scientific world. Dr. James Blake, who has made this subject a special study, thinks that all the California earths are of the miocene age.

The following is a list of the localities represented in the State Museum, samples of which (except the Santa Monica) will be furnished to specialists who make application for them. The numbers refer to the Museum catalogue:

35. Santa Monica, Los Angeles County.
175. Ione Valley, Amador County.

240. Los Angeles County.
436. San Gregorio, San Mateo County.
444. San Joaquin Valley, near San Carlos Ranch.
547. Seacoast, 40 miles north of San Diego.
557. Staples' Ranch, San Joaquin County.
654. Ten miles north of Petaluma, Sonoma County.
791. Santa Barbara.
830. Monterey County.
1184. Near Comanche, Calaveras County.
1246. Lost Spring Ranch, Lake County.
1284. Santa Catalina Island.
1331. Dutch Flat, Placer County.
1448. Port Harford, San Luis Obispo County.
1742. Fourteen miles below San Pedro, Los Angeles County.
1832. Eighteen miles southeast of Santa Rosa, Sonoma County.

Of all those mentioned above, the Santa Monica is the most noted. Slides of this material grace the cabinets of microscopists in all parts of the world, and yet the deposit from which it came is not known. The history of the specimen which furnished so much to science is interesting.

In March, 1876, Mr. Thomas B. Woodward, then connected with the United States Coast Survey, sent a fragment of diatomaceous earth to the California State Geological Society, which he found in tidal refuse on the seashore near Santa Monica, Los Angeles County. The piece could not have weighed more than two pounds, and had so long been subjected to the action of the waves that the edges and angles were rounded. The exact locality was two miles southeast of the lagoon, and several miles southeast of Santa Monica. He saw no other sign of a deposit of the earth. The genuine Santa Monica (which name refers to the waif) is now the most interesting of any known, and is prized above gold. Several attempts have been made to discover the origin of the fragment, but so far without success.

The following list of diatoms found in the Santa Monica will give some idea of its prolific character. The list is by no means complete, being only those identified by William J. Gray, M.D., of London, England; Charles Stodder, of Boston, Mass.; F. H. Engels, M.D., of Nevada City, Cal., and Wm. Norris, of this city. The State Mineralogist will be pleased to receive contributions to the catalogue from any diatomist who may see this article:

DIATOMS FOUND IN THE SANTA MONICA EARTH.

1. Actinophæni splendens.
2. Actinoptychus superbus.
3. Actinocyclus interpunctatus.
4. Arachnoidiscus ornatus.
5. Arachnoidiscus ehrenbergii.
6. Amphitetras elegans.
7. Amphitetras wilkesii.
8. Asterolampra variabilis.
9. Asteromphalus darwinii.
10. Auliscus elegans.
11. Auliscus mirabilis.
12. Auliscus notatus.
13. Auliscus pruinosus.
14. Auliscus racemosus.
15. Auliscus reticulatus.
16. Auliscus sculptus.
17. Auliscus hardmanianus.
18. Aulacodiscus browneii.
19. Aulacodiscus kittonii.
20. Aulacodiscus margaritaceus.
21. Aulacodiscus oregonensis.
22. Aulacodiscus pulcher.
23. Biddulphia aurita.
24. Biddulphia johnsoniana.
25. Biddulphia tuomeyii.
26. Campylodiscus.
27. Chætoceros.
28. Climacosphenia moniligera.
29. Cocconeis parmula.
30. Cocconeis punctatissima.
31. Cocconcis fimbriata.
32. Cocconeis scutellum.
33. Cocconeis splendida.
34. Cocconeis pseudomarginata.
35. Cocconeis grevillii.
36. Coscinodiscus gigas.
37. Coscinodiscus concavus.
38. Coscinodiscus oculus-iridis.
39. Coscinodiscus subtilis.
40. Coscinodiscus robustus.

41. Cosmoidiscus elegans.
42. Cresswellia rudis.
43. Dictyocha (?) variens.
44. Ditylum.
45. Discoid forms—rare and very plenty.
46. Euodia gibba.
47. Eupodiscus oculatus.
48. Eupodiscus rogersii.
49. Endyctia oceonica.
50. Gephyria constricta.
51. Gephyria gigantea.
52. Gephyria incurvata.
53. Gephyria telfairiæ.
54. Grammatophora marina.
55. Grammatophora—unnamed large variety.
56. Grammatophora macilenta.
57. Grammatophora serpentina.
58. Goniothecum.
59. Glypodiscus stellatus—4, 5, and 9 processes.
60. Hyalodiscus californicus.
61. Hemiaulus californicus.
62. Hercotheca.
63. Heliopelta leeuwenhoekii.
64. Heliopelta nitida.
65. Isthmia nervosa.
66. Melosira sol.
67. Navicula californica.
68. Navicula excavata.
69. Navicula lyra.
70. Navicula nebulosa.
71. Navicula prætexta.
72. Navicula spectabilis.
73. Omphalopelta moronensis.
74. Omphalopelta versicolor.
75. Plagiogramma.
76. Pleurosigma.
77. Podosphenia.
78. Porpeia quadrata.
79. Porpeia ornata.
80. Rhabdonema adriaticum.
81. Raphoneis.
82. Rutilaria epsilon.
83. Rutilaria obesa.
84. Stictodiscus californicus.
85. Stictodiscus hardmanianus.
86. Stictodiscus—new form.
87. Synedra—very large.
88. Stephanopyxis oblongus.
89. Stephanopyxis umbonatus.
90. Surirella.
91. Stauroneis aspera.
92. Triceratium arcticum.
93. Triceratium montereyii.
94. Triceratium parallelum.
95. Triceratium wilkesii.
96. Triceratium—large variety of forms.
97. Triceratium, with five or six angles.
98. Xanthiopyxis—new.
99. Xanthiopyxis oblonga.
100. Xanthiopyxis umbonatus.

50. DOLOMITE. Named from the French geologist Dolomieu. Carbonate of Lime and Magnesia.

When pure it has the following composition:

Carbonate of lime	54.35
Carbonate of magnesia	45.65
	100.0

H=3.5—4, sp. gr. 2.8—2.9; color, white, gray, green, brown, and nearly black. Many limestones contain magnesia, and are classed as magnesian limestones. Dolomite may be distinguished from limestone by the feeble action of cold acids upon it, although when the acid is hot, the effervescence produced is energetic. Dolomite makes better and more durable mortar than ordinary lime, and it is generally an excellent building stone, though some varieties decompose when exposed to the humid, smoky, and sometimes acid atmosphere of large manufacturing cities, like London. Dolomite is rather abundant in California, and is found, according to Blake, at the following localities: Amador County, in narrow snow white veins, traversing a talcose chloritic rock and bearing coarse free gold; Calaveras County, Angel's Camp, in the Winter Hills and other mines, massive, with the quartz veins, and bears gold; sometimes in fine crystals, lining cavities; San Bernardino County, at the Amargosa mine, bearing coarse gold. It is also found with pyrite, at Mumford's Hill, Plumas County (Edman), at Mount Catherine, Napa County, and in Mendocino County.

The following localities are represented in the State Museum: (2175) from the Modoc mine, Inyo County. (2238) resembling fossil coral, Moro, San Luis Obispo County. (2524) in nodules, from a few inches to a foot or more in diameter, some of them containing cavities lined with crystals. (4483) pure white variety, Amargosa wash, San Bernardino County. This rock is very common in the Inyo Range, from the White Mountains, Mono County, southward. White Mountain peak is named from the appearance of its summit which seems to be composed of this rock, often mistaken for snow, and which is found in great quantities at its base. (5051) is a specimen of the same from near Independence, Inyo County. (5558) is the same rock found at Tujunga Cañon, San Gabriel Mountains, Los Angeles County.

51. DUFRENOYSITE. Etym. *Dufrénoy*, French mineralogist.

A mineral composed of sulphur, arsenic, and lead. Said to be found in the Union mine, Cerro Gordo, Inyo County (doubtful).

Electrum—see Gold.

52. EMBOLITE. From a Greek word, meaning an intermediate.

This is a chloro-bromide of silver. Except in being dark green in color, it resembles cerargyrite, and may be distinguished by the tests given under that head. It is rather an abundant mineral in southern California, but is seldom found in masses of any considerable size, being generally disseminated throughout the other ores of silver, or occurring in their crusts. It is almost always associated with cerargyrite, for which it is often mistaken. It is found in the Minnie mine, Sweetwater Range, Mono County, and in the Indiana mine, near Swansea, Inyo County. No. 5025 is a large specimen of silver ore (brecciated), a large portion of which is covered with embolite. It is from the Alhambra mine, Calico district, San Bernardino County.

Emerald Nickel—see Zaratite.

53. ENARGITE. Etym. *obvious* (Greek).

This mineral is a sulpho-arsenide of copper, sometimes containing antimony, iron, silver, or zinc. It occurs at least at one place in California, where it is abundant, associated with pyrite and other minerals. It has a disposition to change to arsenious acid and sulphate of copper, a reference to which has been made under the head of arsenolite. The locality is the Morning Star mine, Monitor District, Alpine County, from which there are fine specimens in the State Museum, Nos. 639 and 2832.

54. ENSTATITE. Etym. *An Opponent* (Greek). Bronzite.

This mineral is a silicate of magnesia, alumina, iron, lime, manganese, etc. The variety Bronzite is found in Alameda County. No. 4237 is from the Berkeley Hills.

55. EPIDOTE. Etym. *Increase* (Greek).

Is a silicate of alumina, lime, iron, etc., which occurs sparingly in California, at Long Valley, on the Mohawk road, Plumas County

(Edman), Miners' Ravine, Placer County (Dana). It has been found with copper ores in Calaveras and El Dorado Counties, but the exact localities are uncertain.

Erubescite—see Bornite.

56. EPSOMITE. Epsom Salt, Hair Salt, Sulphate of Magnesia.

$MgO\ SO_3+7\ HO$.

Magnesia	16.3
Sulphuric acid	32.5
Water	51.2
	100.0

This rather rare mineral occurs in the Redington quicksilver mine, Napa County, in curved porous crystals several inches long, white color, nearly wholly soluble in water, gives much acid water in closed tube, and a black sublimate of sulphide of mercury which is present as an impurity. B. B. on ch. melts in its water of crystallization, and becomes pink on addition of nitrate of cobalt at a red heat.

A qualitative analysis shows it to contain alumina, and traces of iron. The small residue left after solution in water was examined microscopically and found to consist of black, yellow, and transparent particles, some sulphide of iron (pyrites), and a small amount of cinnabar. The black particles proved to be magnetite, the yellow free sulphur, and the transparent, selenite—altogether an interesting association, and one that will be studied more carefully in the future. This specimen has been entered No. (6001) in the Museum catalogue.

Erubescite—see Bornite.

57. ERYTHRITE. Etym. *Red* (Greek). Arseniate of Cobalt.

This rare mineral has recently been found in California and Nevada. It is found as a rose-red incrustation on a grayish earthy mineral at the Kelsey mine, Compton, Los Angeles County (2805). It was described by Prof. William P. Blake in "Contributions to the Mineralogy of California," in the appendix to the second annual report of the State Mineralogist, 1882, which is repeated here:

Erythrite: Cobalt Bloom. In minute mamillary incrustations, showing when broken, radial aggregations of silky, fibrous crystals. Color: deep carmine or rosy-red, also, peach-blossom red. Streak same color, but blue after the mineral has been heated. It gives the usual reactions for cobalt, arsenic, and water. Occurs also in massive earthy aggregations, of small fibrous crystals, of a rose-pink color. It is associated with an ore of silver and cobalt in dark colored earthy masses, a mechanical mixture, assaying at the rate of 5,000 to 6,000 ounces of silver to the ton, but the precise nature of which is not yet ascertained, in a gangue of heavy spar, containing also nodular masses of chalcopyrite (yellow copper ore). This is believed to be the first observation of the occurrence of this species in the United States.

This mineral, which is valuable, may be easily distinguished by the following reactions: B. B. on ch. gives off arsenic fumes, which smell like garlic; when the fumes cease, the assay powdered in an agate mortar, yields to a bead of borax a beautiful blue color. The mineral is soluble in muriatic acid, giving a rose-colored solution.

Cobalt is a metal named from Cobalus, the demon of miners. The ores were at first considered mysterious and intractable (Ure).

It is reddish gray in color, sp. gr. 7.7, magnetic, slightly malleable, fuses at a lower temperature than iron, but higher than gold. It has no use in the arts, but its oxide is largely employed to color glass, and in porcelain painting, for which purpose it has been used from the earliest times.

Several pigments are prepared from cobalt, one of which is Rinman's Green, to make which a mixed solution of sulphate of cobalt and zinc is prepared, which is precipitated with solution of carbonate of soda. The precipitate is carefully and thoroughly washed with hot water and calcined.

Thenard's Blue, or Cobalt Blue, is prepared by first precipitating nitrate of cobalt with phosphate of potassium. In another vessel alumina is precipitated from alum by carbonate of sodium, and one part of the first by volume is thoroughly mixed with four parts of the second while still moist. The mixture is then dried, calcined, and ground to a fine powder for use.

58. FELDSPAR—see also Albite, Labradorite, and Orthoclase.

The name Feldspar generally applies to *Orthoclase*, but it also indicates a group of minerals, called the feldspar group, as follows: *Albite*—Soda feldspar; *Andesite*—Soda, lime feldspar; *Anorthite*—Lime, soda feldspar; *Hyalophane*—Buryla, potash feldspar; *Labradorite*—Lime, soda feldspar; *Oligoclase*—Soda lime; *Orthoclase*—Potash feldspar.

The feldspars enter largely into the composition of the rocks which form in decomposing soils, and furnish the alkalies so essential to the growth of plants.

The secondary minerals resulting from such disintegration and decomposition are lithomage, kaolin, halloysite, rock soap, agalmatolite, etc.

It is difficult to distinguish the feldspars from each other in rocks, although they may be readily determined if in sufficiently large masses to admit of their being isolated mechanically. This is attempted even in fine-grained rocks, by treating the powdered rock with successive solutions having different specific gravities. The microscope aids the lithologist. One skilled in the use of the instrument, and practiced in observing rocks cut into thin sections, seldom fails in recognizing the species by simple inspection. Lithology has so direct a bearing on mineral veins and their contents that the prospector would do well to study rocks, by collecting them and observing their characteristics and differences. There are several excellent works on this subject, although generally they have the fault of being too scientific for the average mining prospector, and in not giving sufficient detailed instruction in classification and determination.

The following are practical and fairly explicit, and can be recommended to those who desire to study the very useful and fascinating science of Lithology or Petrology:

Rocks classified and described by Bernhard Von Cotta, London, 1866, and "The Study of Rocks," by Frank Rutley, New York, 1879.

Pinkerton's Petrology is a most excellent work, although published in 1800, but it is out of print and difficult to obtain. There are many elaborate and costly works on this subject published within a few years, and since the microscope has been applied to the study of rocks. Any bookseller would send a list of them on application being made to him.

59. FLUORITE. Etym. *To Flow* (Latin). Fluor Spar, Fluoride of Calcium.

Found only sparingly in small white cubes, with copper ore, at Mount Diablo, Contra Costa County (Blake).

FLUOR SPAR—see Fluorite.

FRENCH CHALK—see Talc.

60. GALENA. Etym. *Lead Ore or Lead Dross* (Latin). Galenite—see, also, Lead. Sulphide of Lead. (Pb.S.)

Lead	86.6
Sulphur	13.4
	100.0

Color, lead gray; luster, highly metallic. H=2.5—2.75, sp. gr.=7.25—7.7, easily fusible. When melted in a crucible with metallic iron, metallic lead and sulphide of iron are produced. B. B. on ch. melts easily, giving off fumes of sulphur; after a continued blowing a button of lead is obtained which generally affords a bead of silver if cupelled. Galena is a common ore of lead and very abundant in California. It is found in the northern part of the State with pyrite and blende, in the gold mines, and in the south with silver ores; sometimes disseminated through the ore, at other times in distinct veins, and in masses of considerable size. The time will come when by a proper system of concentration this mineral will be gathered and will add largely to the lead production of the world. It is found with copper ores in Light's Cañon and in Granite Basin, Plumas County (Edman); in Calaveras County, at Murphy's, in the Star of the West mine, Blue Mountain district, and the Gold Hunter claims (Blake); in Nevada County, with gold in the several gold mines, and at Meadow Lake with blende and gold; in Tehama County at Cow Creek; in Sacramento County at Michigan Bar, with blende and pyrite; in Mariposa County in the Marble Springs mine. Galena is well represented in the State Museum from the following localities: (295) San Bernardino County; (673, 4071) Santa Catalina Island; (1105) New Coso mine, Inyo County; (1302, 4211) argentiferous, Hidalgo mine, Inyo County; (1394, 2112) May Lundy mine, Homer District, Mono County; (1653) Modoc mine, Inyo County; (1880) in quartz, Rising Sun mine, near Aqueduct City, Amador County; (3587) argentiferous, showing radiated structure, Brown Monster mine, Inyo County; (4759) with native silver, partzite, etc., Tower mine, near Benton, Mono County; (5329, 5330, 5331) Soulsby mine, Tuolumne County, in white quartz with heavy gold, pyrite, and blende.

61. GARNET. Etym. *Pomegranate Seeds* (Latin). Andradite.

Garnets are found in a number of localities in California, but no stones suitable for jewelry work, or which could be called gems, are known. According to Blake, garnets are found at the following localities: El Dorado County, at the Fairmount mine, three miles from Pilot Hill, in large blocks and masses two feet thick and more. Associated with specular iron, calc spar, iron pyrites, and copper pyrites, with actinolite in steatite, near Petaluma, Sonoma County. In large semi-crystalline masses, weighing ten to twenty pounds, and of a light color, in the Coso mining district. (Specimens of this were brought to San Francisco under the supposition that it was tin ore.) A beautiful green grossular garnet is found with the copper ore of the Rogers claim, Hope Valley, El Dorado County, and similarly in copper ore at the Mountain Meadows, Los Angeles County. Anderson & Randolph, jewelers of San Francisco, report precious garnet in Calaveras County. Aaron found garnets in clusters near Mono Lake, Mono County. Edman discovered iron garnets in Long Valley, Plumas County. Dana gives the following localities: In copper ore, Mountain Meadows, Los Angeles County; Soledad mine, San Isabel, San Diego County; and chrome garnet near Idria, Fresno County.

Garnets may be seen in the State Museum from the following localities: (243) In mica schist, 30 miles northeast of San José, Santa Clara County; (2365) Peru Mountains, Ventura County.

They also occur in schist at the mouth of Russian River, Sonoma County.

62. GAY-LUSSITE. Etym. *Gay-Lussac*, French chemist.

This is a carbonate of lime and soda found in alkaline lakes in fine crystals. It has no present economic value. Thinolite, which forms mountains in Nevada and elsewhere in the Great Basin, is believed to be a pseudomorph after Gay-Lussite; if this is so, the quantity of carbonate of soda set free must also have been very great. This subject forms the substance of several chapters in the "Geology of the Fortieth Parallel," Clarence King. Gay-Lussite is found in California at Borax Lake, San Bernardino County, and probably elsewhere.

63. GEOCRONITE. Etym. *Earth* and *Saturn*, the alchemistic name for lead (Greek).

Sulphide of lead and antimony, has been observed with galena in small masses in the Inyo Mountains, Inyo County. A specimen was exhibited in the California collection at the Paris Exposition of 1878.

64. GLAUBERITE. Etym. *Glauber*, German chemist.

Sulphate of lime and soda, was found at Borax Lake, Lake County, in blue clay at a depth of 40 feet, having been obtained in an artesian boring (Dana). It is reported also in San Bernardino County, at the borax works, and it is said to exist at the Geysers in Sonoma County.

65. GLAUCOPHANE. Etym. *Glaucus*, sea green color (Latin). Wichtisite.

This mineral occurs in a rock matrix, widely distributed in California, and associated with serpentine. The rock was first observed in 1877, when sections were cut for microscopic observation. A specimen was exhibited at the Paris Exposition of 1878, and when seen by M. Michel Levy was recognized as the "Mica schiste a glaucophane de Syra, Greece," figured in his "Mineralogie micro-graphique des Roches Eruptive Françaises," planche 1, Fig. 2. This rock is represented in the State Museum by No. 4259. The wall rock of the Collier mine, six miles northeast of Murphy's, Calaveras County, and (4720) microscopic slide from near the Wall Street quicksilver mine, Lake County; this is the slide exhibited in Paris.

66. GOLD.

PROPERTIES OF GOLD.

There is probably no metal more generally distributed over the earth's surface than gold, but its physical properties are such that it can only exist in comparatively small quantities within the reach of man. Iron and most other metals have such an affinity for oxygen that they form compounds with that element, becoming oxides, which form secondary compounds with other elements and compounds and become part of the rocks which constitute the earth's crust; gold, and a few other metals, having little or no affinity for oxygen, and for that reason called "noble metals," retain their metallic state and are seldom found otherwise.

The color of pure gold is bright yellow, tinged slightly with red. It has a higher luster than copper, but less than silver, steel, mercury, or platinum. It is softer than silver, and more ductile and malleable than any other metal. When passing from a liquid to a solid state it contracts more than any other metal. The atomic weight of gold is 196.5, hydrogen being taken as unity. It fuses at a temperature of 2016. Fahrenheit. Gold may be distinguished from all other substances by the following simple and characteristic tests: *It is yellow; is not acted on by nitric acid, and it fuses B.B. to a bright bead on charcoal without incrustation.* In sufficiently large pieces, it may be recognized by being *malleable under the hammer, and cutting with a knife without crumbling.*

Gold, when alloyed with other metals, cannot be so easily distinguished, as its associates somewhat modify the reactions. The color of native gold is degraded by metals with which it is alloyed. In some localities it is found pale from admixture with silver, and in others red from the presence of copper.

According to Berthier, the specific gravity of gold is 19.258, which may be increased to 19.376 by hammering. In a melted state it is said to assume a bluish-green color. I have never observed this property of gold. Its tenacity is lessened by hammering or rolling, but it may be restored by subjection to sufficient heat.

Gold leaf is green by transmitted light, but it becomes red when strongly heated. In red gold glass, the metal is said to be in the metallic state. Gold does not oxidize at ordinary temperatures, nor in the hottest furnaces. A slight oxidation takes place when it is exposed in thin leaves to the action of the compound blowpipe, or to a powerful galvanic battery. In a vacuum the electric spark divides it into a very fine powder. Gold is less tenacious than copper, iron, platinum, or silver. A wire of gold only the .078 of an inch in diameter will not break until loaded with a weight of 150 pounds. In cooling after fusion gold forms crystals. Gold is not the most beautiful metal, nor is it the best fitted for all the uses to which it is applied, it being found necessary to alloy it with other metals for certain purposes.

Gold powder or bronze is made by grinding gold leaf in a mortar with honey, extracting the honey with hot water, and drying the powder. It is used in illumination and miniature painting.

Gold is extensively used in the arts. More than 1,000 ounces of pure gold are consumed in Birmingham alone every week, and in the whole of England the weekly consumption of gold leaf is 584 ounces, while for electro-gilding and other uses 10,000 ounces are required annually. Two pottery establishments use $35,000 worth of gold per annum, for gilding porcelain and for making purple and rose colors. Nearly 10,000 ounces of gold are consumed by the Staffordshire potteries annually. Gold has become so plentiful that but few persons are met who do not have this metal about their person, either as coin, jewelry, or timepiece. The amount of gold used and lost in ornament is beyond calculation.

Native gold is usually found in scales, threads, plates, and irregular masses, from a few grains in weight to many pounds. Although generally amorphous, it is frequently found in crystals, which usually assume some modification of the octahedron. Crystals of gold are never found large. Beautiful microscopic octahedral crystals of gold are found in the Ida mine in Inyo County, California, and at the White Bull mine, Linn County, Oregon. Many substances are mistaken for gold. Some varieties of mica resemble it in certain lights, so much as at times to deceive the most experienced eye. Chalcopyrite or copper pyrites, or even iron pyrites, are sometimes mistaken for it; and wulfenite or molybdate of lead, quite common in Nevada and Eastern California, bears a perplexing resemblance to it.

One grain of pure gold is worth $0.0430663; one gramme pure gold is worth $0.6646+; one ounce troy of gold is worth $20.671791; one pound avoirdupois gold is worth $301.46+; one ton (2000 lbs. =29,166.6 oz. troy), $602,927.36; one cubic inch (10.12883 oz. troy), $209.38; one cubic foot (17,579.9808+ oz. troy), 1,205.4898 pounds avoirdupois; value $363,409.85. The standard fineness United States gold coin=900; one cubic inch of standard gold, 9.0989 oz.=$169.28; one cubic foot standard gold=$292,500.00. The average specific gravity of California gold dust, as it would be in a box or bag, was found by the United States Mint to be 9.61. It occupies about twice as much space as when melted into bars. A rectangular box, eight by ten inches and five inches deep, will contain $36,000 in gold coin laid in order, and $27,000 poured in and shaken. A bag six inches by nine inches will hold $5,000 in gold coin with room to tie.

ALLOYS OF GOLD.

Gold alloys readily with most metals, the various compounds having physical properties almost characteristic as distinct elements. This is the case more especially when the metals are combined in chemical equivalents.

The only alloys of gold which find extensive use in the arts, are those of silver and copper; pure gold is too soft and too costly a metal to be suitable for coin, or for manufacturing purposes. It is, therefore, hardened by the addition of other metals.

Jewelers' gold is alloyed to suit the purposes for which it is required. The following are some of the alloys, with the technical names given to them:

Yellow gold, pure gold	1000	Rose copper	----	Silver	----
Red gold, pure gold	750	Rose copper	250	Silver	----
Green gold, pure gold	750	Rose copper	----	Silver	250
Dead leaf, pure gold	700	Rose copper	----	Silver	300
Water green, pure gold	600	Rose copper	----	Silver	400
Blue gold, pure gold	750	Iron	250	Silver	----

White gold contains silver in excess.

Alloys are also made by the jewelers, and the manufactured articles acted on by acids. The surface becomes pure gold, and the composite nature of the alloy is dishonestly concealed. The solution said to be used for this purpose, is a mixture of two parts of nitrate of soda, one part of chloride of sodium, one part of Roman alum, in three or four parts of distilled water. The articles are boiled in this solution until the proper shade or color is obtained, generally fifteen to twenty minutes. They are then taken out, washed and burnished.

The alloys of gold and copper are more fusible than either of the metals alone. Copper gives the alloy the required hardness.

Silver and gold form useful alloys, but are liable to separate if the crucible in which they are melted is allowed to stand without being stirred; the alloy is harder than either of the metals. The hardness is at its maximum when the proportions are two parts of gold to one of silver. Twenty parts of gold becomes visibly whiter when alloyed with one part of silver. This alloy is more fusible than pure gold.

Platinum does not alloy readily with gold. To form this alloy, it is necessary to fuse the metals at a very high heat, or the platinum will only be disseminated through the gold. The alloy has the color of bell metal, or tarnished silver. When the platinum is in the proportion of one sixth, the color of gold is lost. An alloy of equal parts of gold and platinum has the hardness of wrought iron. It is slightly ductile.

Gold and antimony form an alloy, which has a pale, dull color; it is exceedingly brittle. The fracture is ash colored.

Alloys of gold with lead have a color from that of pure gold to white, according to the amount of lead employed. All these alloys are brittle, some as much so as glass; the alloy is brittle, if only a trace of lead is present. Even the fumes of lead are said to give gold an inconvenient brittleness.

In the United States the value of an alloy of gold is always expressed in thousandths. The coin of the United States is nine hundred fine, containing nine hundred parts of pure gold in one thousand parts. The gold is melted with one hundred parts of an alloy of nine tenths of copper and one tenth of silver, thus: Gold, nine hundred; copper, ninety; silver, ten; total, one thousand.

In England the gold in alloys is expressed in carats; the carat is divided into four grains, which are subdivided into quarters and eighths. Pure gold is twenty-four carats fine. The standard of gold in England is twenty-two parts of pure gold to two of copper.

It may sometimes be interesting to know the relation between the fineness of gold and its value in carats. Pure gold (one thousand fine) is said to be twenty-four carats fine; twelve carats would evidently be five hundred fine, or one half gold. The following table will show the relative value:

Carats.	Value.	Carats.	Value.
1	.041667	13	.541667
2	.083334	14	.583333
3	.125001	15	.624555
4	.166667	16	.666667
5	.208333	17	.707333
6	.250000	18	.750000
7	.291666	19	.791666
8	.333333	20	.833333
9	.374999	21	.874999
10	.416667	22	.916666
11	.458630	23	.958333
12	.500000	24	1.000000

The following table gives the properties of the alloys of gold with other metals:

Brittle Alloys and their Colors.		Malleable Alloys and their Colors.	
Cobalt	Dull yellow.	Manganese	Gray.
Nickel	Brass yellow.	Iron	Gray.
Antimony	Pale yellow.	Copper	Yellow.
Zinc	White.	Tin	Pale yellow.
Bismuth	Brass yellow.	Silver	Pale yellow.
Lead	White.	Platinum	White.
Rhodium	Yellow.	Palladium	Gray to white.
Mercury	White.	Iridium	Pale yellow.
		Osmium	Pale yellow.

Gold is not found in nature alloyed in chemical equivalents.

VOLATILITY.

Homberg was the first to notice that gold was volatile at a very high temperature. His experiments were made with a large lens, by the aid of which he readily volatilized gold leaf. If a slip of gold foil, or leaf, is placed between plates of glass, the ends being allowed to project, and a powerful current of electricity passed through it, the gold will disappear, while a purple stain will be left on the glass. This experiment was first made by Franklin.

Advantage is taken of the power of electricity to volatilize gold by spectroscopists, when they desire to examine the spectrum of that metal. Some years ago, in Calaveras County, an old furnace used in roasting pyrites, preparatory to its treatment by chlorination, was torn down, and the arch found to be coated with gold. A specimen is preserved in the Museum of the University of California. This is a proof that gold is volatile at a comparatively low heat.

Some interesting experiments made by Mr. James Napier, assayer of the Mexican Mint, published in the Quarterly Journal of the Chemical Society, London, 1857, also show that gold is volatile at a comparatively low temperature. The same experiment was made a number of years ago at the old mint at San Francisco, when gold was discovered on the roof of that building. The experiments of Mr. Napier show that gold, when alloyed with copper, becomes volatile in proportion to the copper present, and to the degree of heat. In one experiment, gold was melted in a small clay cup, with a cupel inverted over it. On removing the covered cup from the fire the cupel was observed to show the characteristic purple stain of gold. A second experiment gave positive proof of the volatility of the precious metal. Observing fumes rising from a black lead melting pot, he placed a bell glass, wet with distilled water, over the pot, and within a few inches as it was being poured, the exposure only occupied one minute of time; on examining the under surface of the glass very many minute globules were observed. The bell glass was washed with water and again examined. The metallic powder was collected, cupelled, and a globule of gold obtained, weighing 4.25 grains.

In refining platinum by the process of St. Claire de Ville, gold, with other metals, is volatilized by the heat required to melt the platinum. This high heat is produced by the compound or oxyhydrogen blowpipe. In melting the natural platinum alloys the foreign metals, such as copper, lead, iron, silver, and gold, are eliminated, and the platinum brought to a state of great purity, simply by raising the heat to a point at which the foreign metals are volatilized. Gold is seen to escape in fumes of a purple color.

DIVISIBILITY.

Recent investigation leads to the opinion that gold, in a state of extreme division, is omnipresent in the earth's crust. T. Sterry Hunt, in his work, "Chemical and Geological Essays," quotes other authors to show that the sea water on the British coast contains, beside silver, gold in solution, estimated to be about one grain to a ton of water. Mr. J. Cosmo Newbery, Chemist of the Geological Survey of Victoria, Australia, has made some very interesting investigations bearing on the divisibility of gold. He found that the water in certain gold mines contained gold. The timber used to support the mine was carefully assayed, and in nearly every case was found to contain gold. R. Brough Smyth, Chief of the Survey, came to the conclusion that the gold was precipitated from solution.

Mr. Newbery had reason to believe, from examination of specimens, that gold was being deposited in many mines. He thinks, however, that finely divided gold is held in suspension in mine water, but not in solution. A sample of mud deposited from mine water of a mine on Hasler's line of reef, Sandhurst, was examined, by careful washing, and the heavier particles were found to consist of auriferous pyrites and free gold. The particles of gold were large enough to be recognized by the microscope. They were in irregular flattened grains.

Pure gold is the most malleable of metals, and there seems to be no limit to its ductility. A single grain has been drawn into a wire five hundred feet in length. It may be beaten into leaves which are only the 282,000 part of an inch in thickness. Reaumer covered a cylinder of silver with .002778 of its weight of gold. It was drawn into a wire, six feet in length of which weighed one grain. This wire was then rolled until it was the one forty-eighth of an inch wide, which increased its length to seventy-five feet. The coating of gold was so perfect that the microscope failed to detect the color of silver. In the days of Pliny gold was beaten so thin that one ounce was flattened into 750 leaves, four fingers square. It has been calculated that the leaves were three times thicker than ours. Gold has been beaten so thin in modern times that 367,000 leaves would only make an inch in thickness, if piled upon each other. The same number of leaves of ordinary printing paper would make a pile seventy-five feet high. Compared with the thickness of the gold on fine gilded wire, gold leaf is thick. It has been calculated that it would take 14,000,000 films, such as sometimes put on the fine wire of which gold lace is made, to equal an inch in thickness, while the same number of leaves of printing paper would make a pile 3,000 feet high. One ounce of pure gold is supposed to be sufficient to gild such a wire 1,300 miles in length.

PLACER GOLD.

When perfectly clean gold is exposed to the action of pure quicksilver, it is instantly seized by the latter and coated with amalgam. The accident of gold being alloyed with other metals in nature does not impair its affinity for mercury, if the surface is made bright mechanically by filing or scraping. Much of the native gold found in placer mines, apparently clean, is slightly tarnished by the oxidizing or mineralizing of its alloy, in which case it amalgamates with difficulty. I have failed in every instance to find gold in quartz in this condition, although intelligent miners have informed me that they have sometimes observed it in their experience. A large proportion of the placer gold found in California is wholly or partly coated with silica, cemented by sesquioxide of iron. When wholly coated it is perfectly inert to the action of mercury (one might as well put gold in a glass bottle and attempt to amalgamate it from the outside). When partly coated, the exposed parts become amalgamated, and to that extent only is the gold held by the mercury. If rusty gold is digested in hydrochloric acid the iron is dissolved, and a slight mechanical force then serves to detach the silica, when amalgamation takes place without difficulty. There is no hope of being able to free the gold from this coating during the few hours it is exposed to the forces employed in the well known hydraulic process. When clean gold amalgamates it does not become homogeneous, but the amalgam forms only on the surface. I have had a piece of placer gold in mercury, standing in my laboratory, for several months, during which time I have frequently triturated it—sometimes several times a day—and it is not yet dissolved; still, in pouring from one vessel to another, the mercury flows freely without showing the gold, but I can at any time fish it up with my finger. Gold so amalgamated could not, in the process of placer washing, escape from the mercury, but coated gold, under the same circumstances, will float on the surface of the quicksilver, and any slight force sufficient to overcome its specific gravity will detach it.

The coating of gold may be imitated, as found by experiment. A piece of pure gold, after annealing, was placed in pure mercury, and it instantly became amalgamated. Another portion, exactly similar, was hammered on a perfectly clean and polished anvil, with a polished hammer, and placed in mercury like the first. It became as quickly amalgamated. Pure quartz was then ground to a powder and sifted on the anvil in a thin stratum. A third piece of the same gold was then laid on the powdered quartz, struck several times with the hammer, turned over, placed on a different spot, and again hammered. The gold was then examined under the microscope, and seen to resemble the coated gold found in the placers, the quartz particles being imbedded in its surface. When placed in mercury, and allowed to remain for some time with frequent agitation, it floated on the surface, and seemed to be wholly unacted upon, but when placed under the microscope it was found that the mercury had attacked the gold through the small interstices, but only to a very limited extent. The gold was then placed on an iron slab, and gently rubbed with an iron muller, by which treatment it became more perfectly coated, and was now an exact imitation of the natural coated gold, minus the iron cement. In the natural coating of placer gold I consider the cementing to be a secondary process, and the sesquioxide of iron to result from decomposing pyrite, which was abundant in the quartz veins that yielded the gold.

Mr. Goodyear thinks, and with good reason, that vast quantities of gold lie under the great valleys of the State, between the Coast Range and the Sierra, which can never be recovered. It has been pretty generally established that the most productive portion of known quartz ledges lie comparatively near the surface; this being admitted, there is reason to believe that if the bedrocks below the present workings should become in time disintegrated, a smaller portion of gold would be set free.

CHEMISTRY OF GOLD.

Ter-oxide of gold is a dark-colored powder, and its hydrate the same color, but of a lighter shade; both are reduced to metallic gold by the action of light and heat. Oxide of gold dissolves in hydrochloric acid, and partially, in sulphuric and nitric acids. All the salts of gold are yellow, and retain this characteristic color even when largely diluted. The salts are decomposed when heated—they have the property of reddening litmus paper even when free from other acids. Hydro-sulphuric acid precipitates all the gold from neutral or acid solutions. This precipitate is ter-sulphide of gold. The precipitate does not yield to any single acid, but dissolves readily in nitro-muriatic acid, and in the sulphides of the alkalies. Sulphide of ammonium also throws down gold from solution, as the ter-sulphide, which redissolves wholly in excess of the reagent, when an excess of sulphur is present.

Proto-sulphate of iron precipitates gold from solutions in the state of finely divided metallic gold powder, at first black, but which becomes gold color and metallic when dried and heated to redness. Gold so treated is chemically pure.

Ter-oxide of gold has the properties of an acid, and is called "auric acid." It may be prepared by digesting a solution of ter-chloride of gold with magnesia, washing the precipitate with water, and dissolving out the excess of magnesia with diluted nitric acid.

Hydrated-ter-oxide of gold forms salts with the alkalies, which are called by chemists "aurates." If finely divided gold be heated with sulphur in the presence of carbonate of potassium, a double sulphide of gold and potassium is formed, which is used in gilding porcelain. If highly concentrated sulphuric ether be added to an aqueous solution of ter-chloride of gold, the chloride will leave the water and take to the ether, which may be separated by decantation. This ethereal solution is used in gilding.

Metallic gold is insoluble in nitric, sulphuric, or hydrochloric acids, but dissolves in fluids evolving or containing chlorine. Nitro-hydrochloric acid is the usual solvent. The solution contains ter-chloride of gold. "Aqua regia," so called by the alchemists because gold (the king of the metals) was conquered by it, is a mechanical mixture of nitric and muriatic acids, generally in the proportion of one of the former to three or four of the latter. Gold is used as a reagent in analytical chemistry as a test for nitric acid—the substance to be tested being boiled with the muriatic acid and the gold leaf added. If nitric acid is present the gold will be dissolved.

Proto-chloride of tin in solution, mixed with ter-chloride of gold also in solution, throws down, even if the solutions are dilute, a purple precipitate with a violet shade. This is one of the most delicate and characteristic tests for both gold and tin. If the solutions are too dilute to give a precipitate, the violet color is still imparted to them. The precipitate is called Purple of Cassius, from a Dutch chemist, who lived at Leiden in the seventeenth century. Purple of Cassius may also be made by forming an alloy of gold, tin, and silver, and dissolving out the silver with nitric acid. To be able to do this, the latter metal must be in considerable excess. Gold Purple is used as a pigment. The composition of the precipitate is not well understood by chemists, but is regarded as a compound of binoxide of tin and protoxide of gold, mixed with protoxide and binoxide of tin and water. Ter-chloride of gold is prepared by dissolving gold—which may contain silver or copper—in aqua regia, evaporating to remove excess of acid, diluting again if necessary; filtering to remove chloride of silver, acidulating with muriatic acid, and precipitating the gold with solution of protosulphate of iron. The precipitate must be washed on a filter with distilled water, dried, redissolved in aqua regia, and evaporated on a water bath to crystallization. Chloride of gold is obtained by evaporating a solution of ter-chloride of gold to dryness, heating the powder on a sand bath at the temperature of melting tin, and stirring as long as chlorine is evolved.

Ammonia precipitates from concentrated solutions of gold an orange colored precipitate of aurate of ammonia called also "fulminating gold." It is a very dangerous substance—it can be dried at 212° F.—but the slightest friction causes it to explode with the greatest violence. A dreadful accident happened in the laboratory of Beaume—an assistant lost both of his eyes by the explosion of a vial of fulminating gold, caused by the friction of the glass stopper.

Gold may be separated from alloys of other metals, with the exception of tin, antimony, and platinum, by simply boiling with nitric acid, but the gold must not be present in a larger proportion than one fourth. Should the proportion be greater, silver or copper must be melted with the alloy, which must be granulated by pouring, while in a fluid state, into water. Upon being boiled in concentrated nitric acid, the other metals will be dissolved, leaving the gold as a metallic powder. Gold is also separated from alloys by means of strong sulphuric acid. The alloy is granulated, as above, and treated in a suitable vessel of platinum or cast iron. Two and a half parts, by weight, of 66° acid is added, and heat continued as long as sulphurous acid is evolved. By this treatment silver and copper become soluble sulphates, while the gold remains unchanged. The solution is poured off, and the gold again boiled with a fresh portion of acid, of 58° Beaume, and the whole allowed to remain for a time at rest. The gold settles from the solution, after which silver is precipitated by plates of copper, the copper replacing the silver, which, with the copper in the alloy, is crystallized out as sulphate of copper, or precipitated, as metallic copper, by plates of metallic iron. The gold still contains a small portion of silver, which is separated by a second boiling with strong sulphuric acid, after which it contains only .005 per cent. This process is not suitable for alloys containing more than twenty per cent of gold. If richer, the alloys must be remelted, with the addition of sufficient silver to reduce them to this standard.

ELECTRUM—NATURAL ALLOY OF GOLD AND SILVER.

It is a well known fact that the gold in California is argentiferous. Formerly the average fineness was 885, but it is not now so high. The record of the assay of several millions of dollars worth of California gold at the Philadelphia Mint showed an average of 880, the sample lots having a range between 870 and 890.

There is a region of country, lying partly in California and partly in Nevada, in which the gold contains an unusually large quantity of silver. At Aurora, in Esmeralda County, Nevada, the gold is of this nature. During several years' mining in that locality, no true silver minerals, that could be distinguished as such, have been noticed. A blue stain in the rock has, we think, never been examined microscopically or chemically. Most of the rich rock was "peppered" with pale gold, and most of the bullion came from this source.

Many years ago, a specimen of white quartz from the Jeff. Davis mine, situated near Millerton, in Fresno County, was exhibited, in which a quantity of very pale native gold was imbedded.

The Bodie electrum is of a pale yellow color, resembling German silver; has a metallic luster; takes a high polish; is malleable and ductile; its hardness equals 3; it is softer than either a gold or silver American coin, being scratched by both.

Specific gravity, 15.15; contains gold, 633.4; silver, 364.1; total, 997.5.

Electrum is well known to mineralogists, although it is rather rare. The largest mass of which we can find any record was taken from the mines of Vöröspatak, in Transylvania; it weighed twenty-five pounds, and contained twenty-five per cent of silver.

Electrum was also well known to the ancients. Pliny, in his great work on Natural History (book 33, chapter 23), describes it as containing silver in varying proportions. "When the silver is one fifth of the ore, it is known as electrum." He also mentions an artificial electrum made by melting together gold and silver. In writing of the properties of electrum, this ancient writer states "that one peculiar advantage of electrum is its superior brilliancy to silver by lamplight." The reader, however, begins to lose confidence in his judgment when he states seriously that native electrum has the property of detecting poisons; "for, in such a case, semicircles will form on the surface of the goblet, and emit a crackling noise like that of a flame, thus giving a twofold indication of the presence of poison."

Electrum is known from California to Cape Horn, among miners of Spanish descent, as "*oroche*," which fact would indicate that this mineral is not uncommon on the American Continent. The gold of Chili ranges in fineness from 840 to 960.

The following analyses of electrum are from Dana's Mineralogy:

	Gold.	Silver.
Barbara Transylvania	645.2	354.8
Vöröspatak Transylvania	604.9	387.4
Siranovski Altai	609.8	383.8
Schlangenberg Altai	640.0	360.0
Santa Rosa, New Granada	649.3	350.7

There seems to be a law governing the fineness of native gold in countries where mines of silver exist, and it may be reasonably expected that in localities where the gold is found to be argentiferous, silver mines may be discovered, if not already known.

GEOLOGY.

Experience has shown that the soil of gold countries contains particles of gold which may be separated by washing. Beds of streams contain more gold after they enter the plains than before. Gold is found in certain localities in streams. In following them upward toward the mountains it is frequently found that the gold disappears. Many rivers afford no gold while they run in the hills, but it is found on bars below. Gold and iron are found associated in all localities, and it is a question if all pyrites will not afford at least a trace of gold with the same certainty that all lead contains more or less silver.

There is a remarkable instance at a mine in El Dorado County, California, in which small globules of gold are found on the surface of large crystals of pyrite. The gold seems to have been squeezed out of the crystals. Fine specimens of this singular association of minerals may be seen in the State Museum. Humboldt has stated that in Guiana gold, like tin, is sometimes disseminated in an almost imperceptible manner in the granite rocks, without the ramification or interlacing of any small veins. At the Braidwood district, south of Sydney, New South Wales, there exists a variety of feldspathic granite, described by the Rev. Mr. Clarke as being permeated by small particles of gold; and Murchison has quoted a statement by Hoffman, that in Siberia gold is found in minute quantities disseminated through clay slate.

Every variety of placer mining is based upon the fact that gold has a greater specific gravity than most other metals or substances. This property causes it to resist the force of water in motion, which, acting upon other lighter minerals, moves them forward in the direction of the course of the stream, while the gold remains behind, and taking advantage of the agitation of movable particles, caused by the action of the water, gravitates toward the earth's center until arrested by the fixed rock formation, technically known to the miners as "bedrock." It frequently happens that the bedrock of a mountain torrent upon which the gold settles is smooth, and having a descent toward the plains below, the gold is forced forward by the stream, aided by the moving bowlders, until it meets some accidental depression, where it remains. Similar conditions cause other gold particles to move to the same depression, where in time a considerable quantity collects, and a natural placer is formed. In the early history of California such depressions were sought in the beds of modern rivers, and large quantities of gold taken out. When the laws which govern these deposits were still but vaguely understood, the miner could without difficulty pan out almost fabulous quantities of gold dust. These placers were successively discovered and exhausted, after which gold washing became more and more difficult, and costly operations were then undertaken. Beds of swift-running rivers were exposed by turning the waters aside in artificial channels or flumes. Soon other appliances were required and invented to facilitate the collection of the gold from the placers, the cream of which had been skimmed by the lucky ones first on the ground.

Gold has been observed native in the following minerals and rocks: Pyrite, chalcopyrite, galena, sphalerite, mispickel, tetradymite, native bismuth, stibnite, magnetite, hornstone, asbestus, tellurium, orpiment, hematite, barite, fluorite, siderite, chrysocolla, cuprite, granite, porphyry, and quartz. In California it is found at Moccasin Creek, Tuolumne County, in steatite; in the Manzanita mine, Sulphur Creek, Colusa County, in cinnabar; in Mono County in calcite; in the Melones mine, Tuolumne County, in sylvanite; in roscoelite at several localities near Coloma, El Dorado County; in galena, near Walker River; in pyrolusite at the Banghart mine, Shasta County; in chalcedony in the Empire mine, Grass Valley, Nevada County, and in asbestus near Georgetown, El Dorado County.

Dr. Percy thinks that gold is precipitated from an aqueous solution. Murchison holds that quartz is of volcanic or solfataric origin, and has all been in a gelatinous state, in which it included the gold mechanically. He gives as an example, the silicious sinter which rises in a fluid state from Hecla, and coagulates into quartz around the volcanic vents. The oldest rocks are the most likely to contain gold in place, viz.: the azoic and the palæozoic. The general facts relating to the geological occurrence of gold are similar, without regard to geographical position.

Sir Roderick Murchison has assumed that gold cannot be expected in considerable quantities above the palæozoic rocks. It has been observed by other geologists that in California gold is found in abundance in the jurassic and cretaceous formations. These more recent rocks are made up of the older ones, changed by the action of nature's laws, and gold being metallic and free, has gravitated to the position in which it is now found. The great mother vein, which is probably the source of all the gold in California, is so metamorphic in character that its geological age is still unknown; but there are evidences that it is much older than the formation in which gold is found. Had there been no eruptive rocks, gold would probably have been unknown to man.

TESTING AND ASSAYING GOLD AND ORES AND MINERALS CONTAINING IT.—GOLD WASHING IN MINER'S PAN.

The miner's pan is made of the best quality of Russia iron, some are stamped out of a single sheet, while others are jointed like the sections of a stovepipe; no solder is used as it would soon be taken up by the quicksilver frequently used. The miner's pan is, in form, something like the common milk pan, but with the sides more flaring. The usual dimensions are ten inches in diameter at the bottom, sixteen inches at the top, and two and two tenths inches deep. The angle of the sides from the horizontal is thirty-seven degrees. The rim is strengthened by a strong iron wire rolled in. This is the conventional miner's pan, and is the result of thirty-three years' experience in California. The retail price of such a pan, in San Francisco, is ninety cents.

The mode of using the pan, in placer mining, is as follows: Having carefully removed the superficial earth to a point within a few inches of the bedrock, the miner places a portion of the gravelly matter containing gold, in his pan, and goes to a neighboring stream, or pond, and kneeling by the side of the water, sinks the pan containing the auriferous earth slowly beneath the surface, holding it horizontally, and causing the water to flow into the pan equally over the sides; when the pan is full, he lifts it and placing it on his knee or on a convenient stone, he stirs the mass with his fingers.

The skillful miner, in washing a panful of "dirt," unconsciously divides the operation into five stages. He breaks the lumps with his fingers and stirs the contents of the pan until a soft mud is formed. Sinking, now, the pan beneath the water, the second stage commences. This is to so agitate the muddy prospect that gold, gravel, and coarse sand sink to the bottom, while the finer and lighter particles flow over the rim and escape. This being for a time continued, the remaining contents of the pan become clean and the water is no longer loaded with slickens. The third operation is to pick out carefully all the large pebbles and gravel, which are examined, and if found worthless, are thrown aside. The agitation is continued with but little water in the pan, and by a motion of the ball of the thumb, difficult to describe, the coarse particles are raked out and rejected. At this stage a very large proportion of the original prospect has been removed, but every grain of gold lies at the bottom, although still invisible. The fourth operation is to so agitate the remaining contents of the pan (now inclined and only partly under the water) that the coarse sand flows over the edge in a thin stream, every particle passing under the eye of the operator, who may be certain that no gold escapes. This is continued until but a small quantity remains in the pan, when, lifting it from the water, the last operation begins, which is the concentration and perfect separation of the gold. This is effected by an undulatory motion, causing the sand to flow with the water across the bottom of the pan, revealing a cluster of gold particles, if the dirt is rich and wholly isolated. The pan is then inclined toward the sand, leaving the gold stranded in one portion, and the sand and water lying in another. The edge containing the sand is then held over and very near the water, of which the miner lifts a small quantity in the hollow of his hand, and pouring it behind the sand, washes it away, leaving the gold only in the pan. There being no quicksilver used, the gold is collected wholly by its specific gravity.

It usually is found that a small portion of black sand appears beneath the lighter colored residue which results from the disintegration of igneous rocks, which does not necessarily indicate the presence of gold, although if gold is found at all it is generally associated with black sand, as they possess similar specific gravities. The gold may be dried in the pan and brushed out into some convenient receptacle. The last portion of black sand is taken out with a magnet, and the quartz sand gently blown away while the gold lies on a clean piece of paper, or in a peculiar flat scoop of tin plate or brass, made for that purpose.

From this "prospect" the gold washer judges of the value of the claim. Each particle of gold, no matter how small, is called a "color." To find the color is to find at least one particle of gold. From the quantity he will estimate, in a rough way, the value of the gold. He will state, with considerable accuracy, that there are "five cents to the pan," or "one dollar to the pan," as the case may be. Sometimes a large piece of gold will be found; but such a circumstance is quite unusual. The gold washer's pan, in the last stages of the operation described, often contains substances of great interest to the mineralogist; as, for example, beautiful zircons, platinum, unique crystals or scales of gold, occasionally rubies, and even diamonds, too minute, however, to have any but a scientific value, rolled masses of chromic iron, etc.

The miner's pan has become, in California, a sort of *vade mecum*, not only to the miner, but to the millman and the assayer. The same results are obtained in other countries by different appliances. The Cornish miner tests the quality of his tin ores by washing on the blade of a shovel; the Mexican uses a horn spoon, and the Brazilian the batea.

HORN SPOON.

The horn spoon is a long irregular trough cut from a large ox horn. It is divided from the horn by sawing; when first cut is rough and clumsy, but by scraping it is soon reduced to an elegant and convenient vessel, admirably suited for washing small quantities, but too small for utility in placer mining, and open to the objection that it soon warps out of shape, and under the influence of repeated wetting and drying, cracks and becomes worthless. While the horn spoon is inferior to the miner's pan, the Brazilian batea is superior, and should be better understood by miners generally.

BATEA.

The batea is a wooden bowl used in the place of the miner's iron pan, which is a convenient modification of it; but while the iron pan is generally useful, the work done by the batea is better. The Brazilian batea is a rude vessel of wood, but the improved California batea is constructed on scientific principles, and is the invention of Mr. Melville Attwood, of San Francisco, who is remarkably skillful in its use. The following is his description:

Batea is the name given to the gold-washer's bowl, or vanning dish, used in the placer and gold mines of Brazil; a small implement, which affords the most simple method of separating, on a limited scale, the grains of gold from the dirt, sand, pyritic matter, magnetic iron, etc. The form of the batea in common use in Brazil is a circular, shallow, wooden dish, or bowl, rudely fashioned with an adze and chisel, varying considerably in depth and size, but, nevertheless, in practical hands giving remarkable results.

In 1853 I had a few bateas made of a much better form, the inside being turned smooth to the center, in a lathe. I introduced them at that time into the mills under my control at Grass Valley and Agua Fria, where they were used for the purpose of testing or making mechanical assays of the tailings, blanket-washings, and as a concentration to find the percentage of pyritic matter in the vein-stone under treatment.

Some years ago numerous samples of sea beach, or gold sands, were sent to me for examination, and as the batea I had then in use did not separate the gold particles as clean and rapidly as I wished, induced me to make further alterations. After many trials and much trouble, I succeeded in getting the form I now use. Those persons accustomed to use the horn spoon, or pan, would be astonished at the ease and rapidity with which the gold in the sands can be washed out with this improved form of batea. As a concentrator for small parcels, or to test the working of a larger one, nothing that I have yet seen in operation can equal it.

The form of the California batea is such that the sands on the bottom form a perfect sector, the gold, cinnabar, tin ore, galena, or other heavy minerals, lying on the point in the most perfect state of concentration. No matter how small the quantity, it is wholly isolated, and may be observed with a magnifying glass if required.

Mr. John Roach, optician of San Francisco, gives the following directions, by which, he says, any good turner will be able to make them: "A disk of seventeen inches diameter being turned conical twelve degrees, will have a depth of one and seven eighths inches from center to surface. The thickness may be five eighths of an inch. The other edge, perpendicular to axis, will require wood two and one half inches thick for its construction. The best wood is Honduras mahogany."

To millmen it is a most useful implement, enabling them, amongst other things, to test what quicksilver is being carried away in the tailings. Silver ore can easily be separated from its gangues. The lithologist it will help greatly in his examination of the rocks.

The movements of most of the large concentrators can be easily copied, particularly that of the percussion table, but with the difference in favor of the batea, that the shock, either light or hard, can be given and varied as required, by striking the side of the bowl with the hand.

The manner of using the batea may be described as follows: Quite a quantity of water will be required. This may be contained in a tank or large tub, or the operation may be conducted at a convenient place near the bank of a stream or lake. The pulverized ore—several pounds at a time—is placed in the batea, which is gradually sunk in the water. Several times it is broken down with the fingers, while the batea floats on the water. When the ore is thoroughly wet and formed into mud, the batea is taken by the rim with both hands and again sunk in the water. A circular motion is then imparted to it (soon learned by practice). The lighter particles will continuously flow over the edge and sink, while the heavier ones collect at the center.

When only a small portion remains, the batea may be lifted, and the water held in the depression caused to sweep round the center, while one edge is slightly depressed. This motion will gradually remove the heavier particles toward the depressed part. If there is any gold, platinum, galena, cinnabar, or other unusually heavy substance, its gravity will resist the power of the water, while comparatively light particles move slowly forward. The form of the vessel is such that the heaviest matter can be closely observed. If there is a particle of gold present, it will be found at the point, clearly distinct from all other substances. The value of the batea to the prospector cannot be too highly estimated, and it should come into more general use.

Applications for the improved batea have been made to the State Mining Bureau from Australia, where it is to be introduced.

MECHANICAL ASSAY OF SANDS CONTAINING GOLD, CRUSHED QUARTZ, OR OTHER ORE CONTAINING FREE GOLD—BASED UPON COMMON PAN-WASHING OR PROSPECTING.

As this assay is of the utmost practical value to the miner, I shall describe it with minuteness.

It must be understood that this is only a working test. It does not give all the gold in the rock, as shown by a careful fire assay, but what is of equal importance to the mine owner, millman, and practical miner, it gives what he can reasonably expect to save in a good quartz mill. It is really milling on a small scale. It is generally very correct and reliable, if a quantity of material be sampled. The only operation which requires much skill is the washing, generally well understood by those who are most likely to avail themselves of this instruction. These rules apply equally to placer gravels. Take a quantity of the ore—the larger the better—and spall it into pieces of less size than an egg. If more than 500 pounds spread on a good floor and, with a shovel, mix very thoroughly; then shovel into three piles, placing one shovelful upon each in succession, until all is disposed of. Two of the piles may then be put into bags. The remaining pile is spread out on the floor, mixed as before, and shoveled in the same manner into three piles. This is repeated according to the quantity sampled, until the last pile does not contain more than thirty pounds of ore. As the quantity on the floor becomes smaller, the lumps must be broken finer until the last, when they should not exceed an inch in diameter. What remains is removed to an iron slab and, by the aid of an iron ring and hammer, reduced to the size of peas. The whole thirty pounds is then spread out, and after careful mixing, portions are lifted with a flat knife—taking up the fine dust with the larger fragments—until about ten pounds have been gathered. This quantity is then ground down fine with an iron muller, and passed through a forty-mesh sieve. If the rock is rich, the last portion may be found to contain some free gold in flattened discs, which will not pass the sieve. These must be placed with the pulverized ore, and the whole thoroughly mixed, if the quantity is small; but if large, must be treated separately, and the amount of gold calculated into the whole ten pounds, and noted when the final calculation is made.

From the thoroughly mixed sample two kilogrammes (two thousand grammes) must be carefully weighed out. This is placed in a pan, or, better, in a batea, and carefully washed down until the gold begins to appear. Clean water is then used, and when the pan and the small residue are clean, most of the water is poured off and a globule of pure quicksilver (which must be free from gold) is dropped in—a piece of cyanide of potassium is also placed with it. As the cyanide begins to dissolve, a rotary motion is imparted to the dish—best done by holding the arms stiff and moving the body. As the mercury rolls over and plows through the sand, under the influence of the cyanide, it will collect together all the particles of free gold. When it is certain that all is collected, the mercury may be carefully transferred to a small porcelain cup, or test tube, and boiled with strong nitric acid, which must be pure. When the mercury is all dissolved, the acid is poured off, more nitric acid applied cold, and rejected, and the gold then washed with distilled water and dried.

The object of washing with acid the second time is to remove any nitrate of mercury which might remain with the gold, and which is immediately precipitated if water is first used.

The resulting gold is not pure, but has the composition of the natural alloy. Before accurate value calculations can be made it will be necessary to render the gold pure and weigh it carefully.

To purify the gold, it must be melted with silver, rolled out, or hammered thin, boiled twice with nitric acid, washed, dried, and heated to redness. The manner of doing this will be described hereafter.

The method of calculating this assay is very simple. It will be observed that two thousand grammes were weighed out. Let the two thousand grammes represent a ton of two thousand pounds, then each gramme will be equivalent to a pound avoirdupois, or one two-thousandth part of the whole, and the decimals of a gramme the decimals of a pound. Suppose the ore yielded, by the assay just described, fine gold, weighing .072 grammes, it must be quite evident that a ton of the ore would yield the same decimal of a pound. Now, as a pound of gold is worth $301 46, it is only necessary to multiply this value by the weight of gold obtained in grammes and decimals to find the value of the gold in a ton of ore—$301 46×.072=$21 70.

Care must be taken in this assay to keep the cyanide solution rather weak, as gold is somewhat soluble in strong solution of cyanide of potassium, and to remember that cyanide is deadly poison, which should be handled with great care.

The crucible assay of ores containing gold, which is the same for *silver*, will be described under that head.

BLOWPIPE ASSAY OF GOLD DUST OR GOLD BULLION.

A person skilled in the use of the blowpipe, possessing a good balance, can make perfectly accurate assays of bullion or gold dust, but the results will only approximate, unless the whole lot is melted into a bar; as this, however, is not always convenient, the following plan may be adopted:

Pour the gold dust out on a large and perfectly clean sheet of paper, and with the ends of the fingers, mix it thoroughly, occasionally lifting the edge of the paper to throw it together, and again mixing to insure uniformity; then, from various parts, lift small portions, until more than an ounce is collected—this is best done with a flat knife, or by pinching with the thumb and forefinger—from this, weigh out accurately, an ounce troy; place this in a small crucible, add a little borax, carbonate of soda, and nitrate of potash, and melt the whole together—this may easily be done in a blacksmith's forge or in a coal stove—when perfectly melted, set the crucible aside, and when cold, break and remove the gold button; this must be freed from clay and slag by light blows of the hammer on its edges, and subsequent washing. When perfectly clean and dry, weigh again. The loss is water, iron, sand, mercury, and other impurities which may be assumed to be the average of the entire lot. Cut off a small portion from each side with a cold-chisel, wrap the pieces in paper to prevent them from flying, and hammer down on the anvil until thin enough to cut with scissors; place upon charcoal and heat with the blowpipe flame until the paper is burned away, taking care not to melt the gold. Cut with a pair of shears sufficient to weigh exactly the tenth of a gramme, or one hundred milligrammes; a portion should be taken from each of the pieces. The weighing must be conducted with the greatest accuracy, for the success of the assay depends upon precise manipulation.

Blowpipe cupels are made of the finest washed bone ash, formed in a cupel mold of boxwood or ebony, hammered with sufficient force to make them compact, and well dried. They are about half an inch in diameter, and less than that in height. For convenience, they may be supported in a ring of platinum wire, in a handle of cork, or fused into a glass rod, as described in works on the blowpipe.

The assay is continued as follows: Place the assay in the center of a piece of lead foil about half an inch square; fold the lead over the gold, and with the fingers carefully form it into a ball and set it aside. Prepare two assays like this. Take the cupel support in the left hand, and, having lighted a spirit lamp, lift one of the cupels by placing the end of the forefinger in the concave part, and holding it lightly with the thumb, place it in the loop of wire. Heat the cupel by urging the whole of the flame upon it, producing, in doing so, a roaring sound. This is best done by holding the point of the blowpipe outside the flame. When the cupel is hot enough, which is known by its becoming white after first blackening, lift with the pliers one of the assays and place it in the center of the cupel. A steadily-pointed blue flame must then be directed upon the assay until it melts and begins to oxidize, when the flame is changed to a roaring blast, and the cupel moved further from the lamp. Cupellation goes on rapidly if the flame is directed against the cupel beyond the assay, and not directly upon it, and if the cupel is kept cool—that is to say, at the lowest temperature at which the lead can be kept fluid. It will be found advantageous to discontinue the flame for an instant occasionally, and to direct it by short puffs at times. The exact point can only be attained by removing the cupel from the lamp, and returning it gradually, as may be required. As the cupellation goes on, the bead becomes more spherical; little patches of lead oxide form and pass to the cupel, becoming thinner, until at last the gold bead can be seen through the slight film of oxide. When nearly finished, the molten gold spits up towards the flame. At last, at the proper moment, learned only by practice, an instant cessation of the blast causes a flash and a bright yellow golden bead remains on the cupel. When cold, the bead is removed from the cupel with pliers, and placed flat side down on a clean piece of paper. It is then grasped with a large pair of pinchers and squeezed by a strong pressure. This generally removes all adhering bone ash, and renders the button fit for weighing. To make sure, turn it over, examine with the magnifying glass, and brush with a small short-bristle brush. If anything should be found attached to it, a squeeze at right angles with the first will generally remove it. Place the button in the pan of the balance and weigh it carefully. Its weight in milligrammes is the total fineness in hundredths. For instance, seventy-four milligrammes would be 740 fine. With a delicate balance, thousandths can be weighed, each tenth of a milligramme being .001.

The button will probably contain silver. To ascertain the fineness of gold it must be subjected to a second process. The weight of the bead being noted, a cavity is made in a piece of charcoal, held by means of a proper support. In the cavity is placed the gold button, with four or five times its volume of pure silver, and both metals are melted together, before a strong blowpipe flame. The alloy must be thoroughly fused. When cool it is wrapped in paper, hammered flat, heated red hot, to burn away the paper, cleaned with a stiff brush, placed in a test tube with nitric acid, and boiled over a spirit lamp until no more red fumes are given off. A black powder, which is gold, will remain. The tube is then filled up with distilled water, which is poured off carefully, so as not to permit any of the finely divided gold to pass away with it. This must be repeated, and the tube filled full for a third time with distilled water. A porcelain cup is then placed over the tube, like a cap, and both inverted together. The gold falls to the bottom of the cup, and the tube is carefully removed. The water is then poured from the gold in the cup, which is first subjected to a gentle heat, and then made red hot by the aid of the blowpipe. During the process the cup may be held, by the aid of pinchers, over the flame of the spirit lamp, which is urged upwards against it from below. When the gold has assumed its metallic color the operation is finished. When cold, the gold is brushed into the pan of the balance, and its weight, in tenths of a milligramme, noted. The results may be written as follows: Suppose the weight of the cupelled button, in milligrammes, to be 74.4, the total fineness will be 744; weight of gold powder, 69.2=692; fineness of silver, 52. Or, fineness of gold, 692; fineness of silver, 52; total fineness, 744.

It is important in estimating the value of purchased gold dust, to carefully examine, to see if there is any counterfeit, or, as it is called, "bogus" dust present. If all from the same locality, the dust will have a uniform color. Any suspicious looking pieces should be set aside and cut with a cold-chisel while lying on a small anvil. A fair sample of the whole lot of gold dust under examination should then be placed in an evaporating dish, the suspected pieces being placed on top, and nitric acid poured over them. If any reaction takes place, such as effervescence or evolution of red fumes, or if the acid becomes colored, there is foreign matter present, and should this be the case, adulteration or counterfeit gold dust may be suspected.

Place two watch glasses, one on a piece of white paper and the other on black, or other dark color; then, with a glass rod, convey a few drops of the acid from the dish to each. To the white, add a drop or two of ammonia, until it smells strongly ammoniacal; a blue color indicates copper. To the other add hydrochloric acid in the same manner. If a white curdy precipitate forms, which does not dissolve upon the addition of water, silver is being dissolved from the gold dust in the evaporating dish. If the dust is of very low grade, these metals may dissolve in very small quantities. But such gold dust would be easily detected by its inferior color and appearance.

If no action is observed, even after heating the dish, there is no counterfeit present. Counterfeit gold dust is sometimes so heavily coated with pure gold (by the galvanic process) as to protect the base alloy from the action of nitric acid, hence the necessity of cutting all suspected pieces before submitting to the action of the acid. To remove the acid from the gold, wash with water thoroughly, and dry over the spirit lamp.

TO TEST GOLD DUST BY TOUCHSTONE AND TEST NEEDLES.

The needles are described under the head of *Assay of Gold Bullion.*

Select from the samples several pieces, to represent as fair an average as possible, and divide each of them with a cold-chisel. Then with each piece, using the fresh cut edges, make parallel marks on the touchstone, and lay the pieces of gold on the table in the same succession. Wet the gold streaks on the stone with nitric acid, using a glass rod or the stopper of a coin test. If no reaction takes place, and the streaks look as bright and metallic as before, the gold is at least 640 fine, and probably finer even than that; wipe the stone gently with a piece of soft rag, and apply test acid in the same manner; if there is still no reaction, the gold is finer than 750; if any action is observed, the fineness is between the two. Test acid is made by mixing ninety-eight parts of pure nitric acid of thirty-seven degrees Beaumé with two parts of hydrochloric acid of twenty-one degrees, and twenty-five parts of distilled water by measure. If the golden streaks are not acted on by nitric acid, nor by the test acid, take a touch needle marked 700, and make a similar streak on the stone below that made with the samples. Compare the color, and then progress with other needles, both copper and silver, using a higher mark each time, until a color corresponding to that of the samples is had; an approximate knowledge of the quality of the gold will thus be obtained.

But, should nitric acid cause any change in the appearance of the streaks on the touchstone and the preliminary tests in the watch glass indicated copper, try the copper needles and apply them in the reverse order until you hit the color, and find a needle, the streak of which is acted upon in a similar manner by nitric acid. If silver was indicated, use the silver needles. Considerable practice and a good eye are required to obtain accurate results with the touchstone, but this is soon acquired.

Gold dust and retorted amalgam should also be examined for mercury. This is done by putting a small fragment into a glass tube, closed at one end, observing that it falls quite to the bottom. Place the end of the finger loosely over the opening, and heat the closed end of the tube where the piece of gold lies, in the flame of the spirit lamp. If mercury is present, a bright ring will form in the tube above the assay. Upon examination with a magnifying glass, the ring will be found to consist of the minute globules of mercury. To be certain, make a scratch with a file below the ring, and break off the closed end of the tube. Place the end of the now open tube in a few drops of water in a watch glass, and then with a feather, or small stick, the sublimate may be brushed into the water, and by gently shaking, be caused to coalesce into a single globule, in which form it cannot be mistaken for any other substance.

ASSAY OF GOLD BULLION.

Absolutely accurate assays of gold bullion require care, skill, and first-class apparatus. The skill may soon be acquired by practice, but the apparatus must not only be of the very best quality but must be kept in the most perfect state of adjustment. It is not enough to purchase chemicals which are marked "pure," or a balance, supposed to be accurate. The chemicals must be tested, and the accuracy and adjustment of the balance and weights verified before correct results can be certain.

The process of assaying gold bullion is divided into several operations as follows: Melting the crude gold and casting the bar, cutting the assay chips, the assay proper, calculating the results, and stamping the fineness and value on the bar.

For melting, a wind furnace is best, but a good coal stove, such as used in offices, will answer the purpose if the amount operated upon be small. The wind furnace is a square box of fire-brick, built in the form of a cube of three-foot face, with an opening in the center of the upper face. The firebox is about a foot square and fourteen inches deep, provided with an ash pit, movable grate, bars, and sliding cast-iron cover. The flue should be a horizontal opening, about three by six inches, near the top of the firebox, and connected with a chimney at least thirty feet high, to insure a good draft. The furnace can be built by any bricklayer of ordinary skill and judgment. No mortar should be used in laying the fire-brick, but good clay, mixed with a portion of coarse sand substituted.

Gold is generally melted in a black lead crucible. Before such a crucible can be safely used, it must be annealed. Were this neglected, and it should be placed in the fire without this precaution, it would soon fly to pieces. This is caused by the water it contains being converted into steam; and the structure of the material being such that the steam cannot make its escape, destruction of the crucible follows. It is best to commence annealing the crucible some time before it is wanted. It should be set near the hot furnace for several days and turned occasionally. When the fire is nearly spent, it may be placed, rim downward, upon the hot sand in the pan generally placed on top of the furnace. A day or two of such treatment will make it safe to hold it over the open furnace by the aid of the crucible tongs or poker. After it has been frequently turned, and is hotter than boiling water, it is safe to place it, rim downward, upon the burning coals. When the rim is red hot, all danger is passed, and it may be turned and placed in position for the reception of the gold.

If the fuel is charcoal, it will be best not to use small pieces, or at least not coal dust. Pieces the size of an egg, or larger, will make the best fire. When the crucible becomes red hot, a long piece of quarter-inch gas pipe is used to blow out any dust or ashes that may have fallen into it. A cover is then placed on the crucible, and lumps of coal built up around it with a long pair of cupel tongs.

When the crucible has attained a full red heat, one or two spoonfuls of borax, wrapped in paper, are placed in it, using the cupel tongs. When the borax has melted a small quantity of gold dust, also wrapped in paper, is placed in the crucible in the same manner. Several portions may be thus added, according to the size of the crucible. A fresh supply of charcoal must be built up around the crucible when required, the cover having been previously replaced. When the gold has melted down, more is added in the same manner, until the crucible has received all that is to constitute the bar. In the meantime, the ingot mold, in which it is intended to cast the gold, must be made smooth and clean inside. This is best done by rubbing with sandpaper and oil, or with a dry piece of pumice stone. It is then wiped dry and clean with a rag, oiled slightly, and placed on the edge of the furnace in such a position that it may become quite hot; not so hot, however, as to approach redness, nor to cause the oil to burn.

When the gold is in a fluid state in the crucible, the mold must be placed on a level surface and oil poured into it. To make a clean bar, it will be found best to use considerable oil—sufficient to cover the bottom of the mold to the depth of at least one fourth of an inch. The mold should be turned in such a manner as to allow the oil to flow to all parts of its interior, and then placed again level and in the position it is to occupy while casting the gold. If the gold is clean, and the quantity less than fifty ounces, it is best not to attempt to skim it. Two spoonfuls of nitrate of potash may be added, and one of carbonate of soda, and the whole allowed to melt and flow over the surface of the gold. When very hot and the slag perfectly fluid, the crucible is lifted from the furnace and with a bold and steady hand poured into the mold, the crucible being held for a little time in an inverted position, to allow the last portion of gold to flow from it. The oil inflames and remains burning on the slag, which flows evenly on the surface of the gold. If the mold is clean, and of the right temperature, and if sufficient oil is used, a clean bar will result. A little practice will enable the operator to hit the exact conditions. The oil used should be a cheap animal oil; common whale oil answers every purpose; lard oil is also well suited. Coal oil is too inflammable as well as dangerous, and should never be used. When cold, the bar falls easily from the mold; a slight tap with a hammer separates the slag, and the bar may be cleaned with water and nitric acid, or, if necessary, with sand and a suitable brush. A good plan is to place the bar in the furnace until it becomes nearly red hot, and then to quench it suddenly in water. This will be unnecessary if proper precautions have been observed in preparing the mold.

When the gold is very impure—which is the case when in the form of retorted amalgam which has not been properly cleaned—a different method of treatment should be adopted. A larger sized crucible will be required. Three or four times the amount of flux must be put in, with the addition of a spoonful of carbonate of potash. A skimmer must be prepared by forming the end of a large wire, about the size of a common lead pencil, into a spiral about an inch and a half in diameter, and bending it so that when the skimmer is let down vertically into the crucible, the spiral will lie flat upon the surface of its contents. A bucket of water is set near the furnace, and, when the slag has become fluid, and it is beyond question that the gold has become perfectly melted, the skimmer is touched to the slag and gently moved from side to side; a portion of the slag adheres to the iron, the skimmer is removed and plunged into the water, and immediately replaced in the crucible; an additional portion attaches itself to the skimmer, which is again quenched in water. This is repeated until a large portion of the slag is removed, and a new charge of flux, consisting, this time, of borax and nitrate of potash, is allowed to fuse upon the surface of the gold. The first flux is removed from the skimmer by a slight blow with a hammer, and the crucible is skimmed with it as before. This must be repeated until all iron and other impurities have been removed, and the surface of the molten gold appears, when exposed, clean and reflective as a mirror. It may then be poured into the mold, as described before. Care should be taken not to dip the wet skimmer beneath the surface of the gold, or an explosion will take place.

In large meltings it is customary always to skim the gold before pouring, and so far to remove the slag that any remaining portion may be left on the sides of the crucible, and the gold only allowed to flow into the mold. This requires some skill and considerable practice. As it is imperative that the bar should be homogeneous to insure a correct assay, it is usual to mix the melted gold thoroughly before pouring. This is done in the large way by stirring just before lifting from the furnace. It may be done with an iron rod, with a piece of black lead held with the tongs, or with a clay stirrer made specially for that purpose, in which case it will be necessary to allow it to remain in the crucible until it has acquired the temperature of the fused gold; otherwise, a portion of the gold may attach itself to the stirrer and be removed with it. In small meltings it will be found sufficient to mix the gold by giving the crucible a rotary motion while holding it with the tongs just previous to pouring. This must be done so quickly that the crucible has no time to cool. For very small fusions it is best to use a small Hessian crucible, and, when the gold is melted with plenty of flux, to set it aside to cool, and then break the crucible and separate the pieces of crucible and portions of slag by slight blows of a hammer on the edges of the button. It is very difficult to pour small quantities of gold without loss from portions remaining on the sides of the crucible.

When the bar is clean, a small portion must be taken from different parts for assay. It is customary to cut from opposite corners with a cold-chisel, but this is extremely clumsy and in every way inconvenient. If the bar is brittle, a much larger piece may break off with the chip than is required. If the proper sized chip is cut off successfully, it is likely to fly away and be lost. A better way is to bore into the bar in different parts with a small drill. This may be done in a lathe, or by means of a ratchet drill. The bar should be placed in a clean copper pan, so that no loss may occur; the surface borings, resulting from the first revolutions of the drill, should be rejected. Those that follow, to the extent of a little more than one gram, are to be placed in a suitable vessel and carefully preserved for assay. Before cutting or boring the bar, the number of the assay should be stamped upon it, and the same number placed with the clippings. This number should represent the bar through every stage of the assay by which its value is ascertained. Some assayers stamp the initial of their name on the cut faces, so that no portion can be removed after it leaves their hands.

The next step is to ascertain the weight of the bar in troy ounces and decimals. This must be done with the greatest accuracy. A good bullion balance is much to be desired; but a bar can be weighed on a defective balance if it is sufficiently delicate to turn distinctly with the hundredth part of a troy ounce. This method of weighing is called counterpoising, and is conducted as follows:

The beam must first be brought to a level by putting sand, small shot, or other convenient weights into the lightest pan. When in perfect equilibrium, a small weight is placed in one of the pans to test the delicacy of the movement, and if satisfactory the bar is laid in one pan and the equilibrium restored by putting any convenient substance, as sand, into the other. The bar is then removed and ounce weights put in its place, which will be the exact weight of the bar, all errors of the apparatus being corrected by counterpoising, which will be evident to the reader without further explanation. Of course the ounce weights must be proved by experiment to be correct among themselves.

It is sometimes impossible to obtain troy ounce weights, in which case avoirdupois may be used. The same rule as to accuracy applies equally to them. Each pound equals 14.5833 troy ounces. An excess of even pounds must be made with ounces and decimals, which can be prepared by any person of moderate mechanical skill. The value of an avoirdupois ounce is 0.911458 ounces troy, or one sixteenth of a pound. To make the calculation, it is only necessary to multiply pounds by the former and ounces by the latter factor, and add the two together. The following table may be used to facilitate the calculation:

Avoirdupois.	Troy Ounces.	Avoirdupois.	Troy Ounces.
1 ounce	0.911458	13 ounces	11.848958
2 ounces	1.822916	14 ounces	12.760416
3 ounces	2.734374	15 ounces	13.671874
4 ounces	3.645833	1 pound	14.583333
5 ounces	4.557291	2 pounds	29.166666
6 ounces	5.468749	3 pounds	43.749999
7 ounces	6.380208	4 pounds	58.333333
8 ounces	7.291666	5 pounds	72.916666
9 ounces	8.203124	6 pounds	87.499999
10 ounces	9.114583	7 pounds	102.083333
11 ounces	10.026041	8 pounds	116.666666
12 ounces	10.937499	9 pounds	131.249999

Suppose the bar to weigh twelve pounds and nine ounces, set the figures down thus:

10. pounds.
2. pounds.
.9 ounces.

12.9

Look for ten pounds in the table, which will be the same as one pound with the decimal point moved one place to the right; 145,833, opposite two, will be found 29,166; nine ounces will be found to be 8,203, which are to be added as follows:

10. pounds	145,833
2. pounds	29,166
0.9 ounces	8,203
12.9—weight of the bar.	183,202 troy ounces.

When decimals of an ounce are calculated, the values may be taken from the first column of the table. Suppose the decimal to be .7, or 7-10, move the decimal point in the seventh line one place to the left, and the result will be .6380208, which is to be added to the sum of pounds and ounces.

The above method of weighing is sometimes convenient in isolated mining localities where no accurate bullion balance or large sets of troy weights can be obtained.

A table having been given to calculate troy ounces from avoirdupois pounds, the following table has been prepared to reverse the operation, and it will in many cases be found convenient:

Table for Changing Troy Ounces to Pounds and Decimals Avoirdupois.

Troy Ounces.	Pounds—Avoirdupois.	Troy Ounces.	Pounds—Avoirdupois.
1	.06857	6	.41142
2	.13714	7	.47999
3	.20571	8	.54856
4	.27428	9	.61713
5	.34285		

Gold is always estimated in troy ounces and decimals. A convenient set of weights may be constructed as follows:

Ounces.	Decimals.	Ounces.	Decimals.
500	0.500	10	.010
300	.300	10	.010
200	.200	5	.005
100	.100	2	.002
50	.050	2	.002
20	.020	1	.001

The weight of the bar being accurately ascertained, the next step will be "the bullion assay proper."

The method of conducting the assay is as follows: The assayer seats himself before the balance, having the clippings in a convenient position inside the case. Half a gramme weight is placed in the right-hand pan of the balance, and portions of the clippings in the other until nearly correct, but the gold should be in excess. The largest piece is then removed by the aid of a pair of pliers, and touched against a clean file, by which a minute portion is removed. By careful manipulation nearly the exact point will soon be obtained, but with the greatest care; if the balance is delicate, it will be found nearly impossible to adjust the weight so perfectly that the index will not point either one side or the other of the zero. In such a case, it will be necessary to make a memorandum of the error and mark it with the number of the assay, and in weighing the cornet to take the same reading of the index.

The gold is removed from the balance-pan and carefully folded in a piece of lead foil an inch square. Care must be taken in preparing this lead, that it is as pure as possible. It must contain no trace of gold. Its purity being established, it is easily prepared by rolling out to a uniform thickness and cutting into inch squares; these should always be prepared by the assayer himself, and kept on hand in sufficient quantity. Two assays must be prepared, as described above. Two small, well made cupels are then to be placed in the muffle, and when hot, a piece of pure lead, weighing three grammes, is placed in each, which will soon melt and begin to "drive"—that is begin to be absorbed by the cupel—the assays are then to be added, using the cupel tongs. When perfectly melted, the cupels are drawn forward to that point in the muffle which experience has shown to the assayer that cupellation progresses most successfully. When the cupellation is finished, and the buttons have assumed a brilliant yellow metallic luster, they are removed, hammered slightly on their edge on a clean anvil, and examined carefully with a magnifying glass to see that all bone ash has been removed. The two buttons should weigh exactly alike; if this should not be the case, the heaviest one must be examined carefully to see if any particle of bone ash may have been overlooked. If this should fail, there is no recourse but to make another assay, which should agree with one of the first. The correct weight of one of the buttons in half milligrammes represents the total fineness, or the gold and silver in the bar, expressed in thousandths.

The weight of the buttons being carefully noted, pure silver is added and they are again cupelled. It has been found that silver cannot be dissolved out of an alloy of that metal with gold, unless the proportion of silver is at least two and one half times that of the gold. If a larger proportion is used, the gold is left in the form of a powder, and cannot be dried and weighed without danger of mechanical loss. If less, the gold protects the silver, and the action of the acid ceases, while some of the silver remains undissolved. An alloy of three parts of silver to one of gold was formerly taken, from which the common term quartation comes, but of late years the above proportions have been found to be best.

As the button resulting from the first cupellation may contain silver, it will be necessary to ascertain if such is the fact, and, if so, in what quantity it may be present.

A preliminary assay is easily made by means of touch needles, to be described. When great accuracy is required—as in case of many assays of gold from the same mine—half a gramme may be cupelled with five or six parts of silver and the proper quantity of lead, the resulting button rolled out and boiled in nitric acid, as will be fully described hereafter. With the data so obtained it will be easy to make up the proper alloy for the actual assay. By this test the gold will be obtained as a powder, but the results will be sufficiently accurate for a preliminary assay. For all practical purposes the touch needles will give results sufficiently exact, and may be confidently used after a little practice.

Two sets of needles will be required, one, the alloy of which is silver, the other copper. These needles can be made by any handy person. Absolutely pure gold and silver are required.

The ordinary plan is to draw out copper wire through a wire plate with square holes, to about the size of the square point of a tenpenny nail. This is cut into lengths of about two inches—five of these constitute a set. It is best to commence each with pure gold; but only one is actually necessary, for pure gold is, of course, the standard of either set.

Weigh out ten grains of pure gold, melt before the blowpipe in a cavity in a piece of charcoal, hammer square and solder to the end of one of the square wires. This requires some skill and an understanding of the nature of this kind of soldering, but any jeweler can do it from this description. When soldered, file down even with the sides of the wire, and stamp on the wire 1000, which represents pure gold. For the other end make an alloy by weighing out very carefully nine grains of pure gold and one grain of pure silver; these are melted on charcoal together—care being taken that sufficient heat is produced to render the alloy perfectly fluid—hammered square, and soldered in the other end of the first needle. This is stamped 900. One needle being complete, the others are made in the same way, as follows:

Grains Gold.	Grains Silver.	Stamped.
8	2	800
7	3	700
6	4	600
5	5	500
4	6	400
3	7	300
2	8	200
1	9	100

The second set is made in exactly the same way, except that copper takes the place of silver in the alloy.

The only source of error is the heating of the solder so hot that it melts the alloy, and by fusing with it a new and unknown alloy is formed. The alloy should be considerably larger than the needle so that it can be filed down, thus removing the solder from all parts except where the copper is joined to it.

A touchstone is best purchased, but the black quartz stones found in the beds of some rivers and creeks will answer the purpose if they will scratch glass, and acids have no effect upon them. A smooth face should be formed by grinding. The true touchstone is a variety of black quartz called basanite or Lydian stone, from a well known locality. It is also found in Bohemia, Saxony, and Silesia.

The touch needles are used for comparison, as follows: The alloy to be tested is rubbed on the touchstone, leaving a characteristic metallic streak; the needles are then compared with the streak on the stone by placing them in succession beside it, until one is found which appears the same in color to the eye; a comparative streak is then made with this needle, parallel and near the alloy, both of which are then closely observed under a common lens; if they exactly compare, the alloy is supposed to be the same degree of fineness as the needle; if not, a similar experiment is made with needles finer or otherwise, as the case may be; a glass rod dipped in strong nitric acid is then touched to the stone covering a portion of both streaks; the action of the acid gives confirmatory evidence as to the fineness of the alloy.

An example will fully explain the manner of making up the alloy in the bullion assay when the fineness is made known by actual experiment.

Suppose the button is found to weigh 972 one-thousandths of the unit, according to the weights used, and by preliminary assay, the gold 896 fine; which is 896 thousandths. It is evident that there is 896 of gold and 76 of silver in the alloy, very nearly. If these results were accurate, there would be no use of proceeding any further, but the results are only sufficiently so to insure a good alloy for the continuation of the assay. Multiply the gold by 2.5, which will give the silver required to be added to the gold, $.896 \times 2.5 = 2{,}240$; but there is already .076 parts of silver with the gold, which must be deducted, therefore 2,164 is the amount of silver to be added to the button: $.896 \times 2.5 - 76 = 2{,}164$.

In case the touch needles are used, a different calculation will be necessary. The following formula is self explanatory:

Let "A" equal the weight of the button after cupellation in millegrams.
"B"=The fineness of the gold in A, as determined by the touch needles.
"C"=The gold in the button approximately.*
"D"=The silver required for parting (two and a half or three parts).
"E"=The silver already in the button.†
"F"=The weight of the silver to be added to the button for parting.

* $A \times B = C$ } Then $C \times D - E = F$.
† $A - C = E$ }

The silver used need not necessarily be chemically pure, but it must contain no trace of gold. It is convenient to roll it out in thin strips to be cut with scissors as required.

When the proper amount of silver is weighed out it is to be folded in lead foil, with the gold button, and cupelled as before.

Two of the gold buttons which weighed alike in the first cupellation, must be alloyed with silver and treated as above. It is not absolutely necessary to cupel the alloy the second time, but it is convenient to do so while the muffle is hot—it insures a malleable button, which can be rolled out without breaking, and there is more certainty, in unskillful hands, of perfect fusion, and, consequently, perfect mixture of the two metals, which must be effected to obtain perfect results. But the gold and silver may be melted together in a cavity in a piece of charcoal, by a person skilled in the use of the blowpipe, with the same certainty of success as when the muffle is employed.

The buttons resulting from the second cupellation are removed from the cupel, hammered slightly on the edges, to remove bone ash, and afterwards flattened on an anvil by blows from a small hammer, the last blow being given near one edge, to make that part thinner, in order to facilitate the rolling process which follows.

At this stage, before rolling out the alloy, the buttons should be annealed; which can be done in the muffle, if still hot, or upon charcoal, with the flame of a spirit lamp urged with a blowpipe. They are then rolled out into ribbons about three inches long, and rolled up into a spiral form upon a glass rod or lead pencil. A slight pinch, after the rod is removed, will prevent their unrolling. They are then ready for treatment with acid.

The *cornets* are next placed in clean glass flasks and covered with about a fluid ounce of twenty degree nitric acid, placed on the sand bath which acts as cover of the furnace, or on a small sand bath supported on the ring of a retort stand over a spirit lamp, and boiled until no more red fumes are evolved. A folded piece of paper, or a pair of wooden tongs, are used to lift the flasks and pour the acid carefully into some convenient vessel kept to receive it, as the silver is valuable, and may be recovered when a sufficient quantity has accumulated. The same quantity of thirty degree acid is then poured into each flask, and, being placed on the sand bath, again boiled. A small piece of charcoal, which must not contain chlorine, is put into each flask to prevent bumping. After five minutes boiling, the acid is poured off, and each flask is filled up with distilled water, which is carefully rejected, and the flasks again filled with the distilled water, this time quite to the brim. Over the mouth of each flask a dry cup is placed, mouth downward, like a cap, and the flask and dry cup inverted together. The cornet falls gently and without breaking to the bottom of the cup. The flask is then gently raised until on a level with the edge of the cup, when, with a quick side motion, the flask is removed and held for a moment to allow the water to fall from it, when it is set aside. Both flasks are treated in the same way. The water in the dry cups is then poured off without disturbing the cornets, after which each cup with cornet is heated red hot in the muffle. The gold will be found to have regained its natural color, and can be removed without danger and taken to the scales to be weighed. If the operation has been skillfully conducted, the result is practically pure gold. It must be weighed accurately, noting any memorandum regarding the position of the index in weighing out the bullion in the first operation. Its weight in half milligrammes will represent the fineness of gold in the bar, expressed, as before, in thousandths.

Suppose the total fineness to be 970, and the fineness of gold as found by assay, to be 898, by subtracting the result from the first, the fineness of silver will be found to be 072. Now, as one ounce of pure gold is worth $20.6918, one one thousandth will be worth $0.0206718, therefore, an ounce of alloy, containing 898 parts of pure gold, would be worth 898×0.0206718, or $18.56327. The last three decimals may be disregarded unless the bar is very large.

The value of the silver is obtained in the same way. An ounce of pure silver is worth $1.2929, and one thousandth equals $0.0012929. This, multiplied by the fineness of silver as found, would give the value of the silver in each ounce of the bar.

To facilitate this calculation I have computed a table by which multiplication is avoided:

Table for determining the Value of Gold and Silver Bullion.

Fineness.	Gold.	Fineness.	Silver.
.000½	.010335917312	.000½	.000646464646
.001	.020671834625	.001	.001292929292
.002	.041343669250	.002	.002585858584
.003	.062015503875	.003	.003878787876
.004	.082687338500	.004	.005171717168
.005	.103359173125	.005	.006464646460
.006	.124031007750	.006	.007757575752
.007	.144702842375	.007	.009050505044
.008	.165374677000	.008	.010343434336
.009	.186046511625	.009	.011636363628

The manner of using this table is the same as a similar one before described:

800 same as 008 decimal 2 places right	=$16.53746
090 same as 009 decimal 1 place right	= 1.86046
008	= .16537
898 value of gold per ounce	=$18.56329

SILVER.

070 = same as 7—1 place right	$0.0905
002 =	.0025
072 =	$0.0930
Value of gold per ounce	$18.5632
Value of silver per ounce	.0930
Total value per ounce	$18.6562

These results, multiplied by the number of ounces and decimals of an ounce the bar weighs, would be its value in dollars and cents. Suppose the bar weighed 100 ounces:

Value of gold	$1,856.32
Value of silver	9.30
Total value	$1,865.62

The following must be stamped on the bar before it can be sold:

Number of the assay; name of assayer; weight of bar in ounces and decimals; fineness of gold; fineness of silver; total value of the bar in dollars and cents.

When several assays of gold bullion are to be made together, the plan of operation is somewhat modified. Let it be required to conduct nine assays together. Certain tools and appliances will be necessary which have not yet been described.

A piece of hard wood is made about four inches square and an inch in thickness. On one side a portion of the wood projects to serve as a handle; nine half inch holes are bored in the square part nearly through the thickness. On the under surface in each corner a small knob is screwed which serves as feet to raise the board above the table. In each of the holes is to be placed a tube of glass closed at one end. The other end of each is cut off square, and ground flat on a grindstone or emery wheel. The size of the tubes is such that they can be easily removed and replaced in the holes. The tubes are a little more than an inch long, so that they can be easily grasped with the finger and thumb when it is required to remove them from the holes.

Each of the tubes are marked with a letter of the alphabet, from A to I inclusive. This may be done with a writing diamond, or with a corner of a freshly broken file. Near each hole on the board is also stamped a letter, using the same as those marked on the tubes. For want of a better name, let this be called a "tube rack."

On commencing the assay, the bars are first stamped with the running number of the assays, to correspond with the entries in the record book of the assay office. Similar entries are then made on a small memorandum book, and to each entry letters are added, thus: No. 794, A; No. 795, B; No. 796, C, etc. The bars are then all taken to the anvil, and assay chips cut from them, or borings taken in the manner before described. The clippings from the bar stamped 794 must be put into the tube marked A, which is then placed in its proper hole; those from 795 in the tube marked B, etc. The bars are then set aside, and the tube rack taken to the balance. Here other apparatus will be required. A square block of wood, with a single hole bored in it the same size and depth of those in the tube rack, and another square piece of wood, with handle, of the same size and thickness as the tube rack, but instead of holes, nine hemispherical cavities are cut, each of which is about an inch in diameter and half an inch deep. These cavities are marked with the same letters, and in the same succession, as those of the tube rack. The tube marked A is lifted from the rack and placed vertically in the hole in the second block, which serves for a temporary stand for it. The clippings that are contained in it must previously be poured out on a clean piece of paper, placed, for convenience, inside the balance case. After the assays are weighed out, the remaining gold is put back into the tube. The assays, in their leaden envelopes, are placed in the cavity marked A. B is then treated in the same way, and so on through the whole set.

Nine cupels are then marked and placed in the muffle in the same order and with the same letters. The object of marking the cupels is, that it is sometimes necessary to change their position in the muffle, and even to take one or more of them out, before the others are finished.

The manner of marking the cupels is as follows: Some red chalk is ground fine, mixed with water, and kept in a small wide-mouthed bottle for use. When required to mark cupels, the contents of the bottle are stirred and applied with a small camel's hair brush. The cupels should be marked on two sides.

When the cupels are taken from the muffle, they are placed in a rack of sheet iron divided into nine compartments, and when the buttons are removed they are placed back into the cavities in the board from which they were taken when placed in the cupels. This serves to convey them to the balance, when they are weighed, alloyed with silver, and returned to the muffle for second cupullation. It will be seen that to this stage the assays are always kept in compartments bearing their mark, and with ordinary care no mistake can occur.

When the assays are alloyed with silver and rolled out, the proper letter is stamped on the end of each, somewhat deeply. The assay is then rolled up in spiral form in the usual manner, commencing at the end which is not stamped. This letter will be as distinctly seen after boiling in acid as before. The cornets are then placed in flasks, boiled with acid, and dried in the usual manner.

It has been recommended to place all of the cornets in one flask, and after boiling, to invert it in a somewhat capacious dish of water; to pick out the cornets with a pair of forceps, and to anneal them altogether in the muffle on a tile. I have never tried it, but I consider it to be unsafe, as with the best of care the cornets are sometimes broken in the boiling. The elegant plan of boiling a number of cornets in baskets of platinum wire, in one vessel, is open to the same objection.

Before attempting to make a gold bullion assay, the following sources of errors should be known:

First, those errors which may result from the non-adjustment of the balance and weights. If the balance is sufficiently delicate, *most* of the errors may be disregarded if the weights are always placed in the same pan; and *all* of them by counterpoising, which has already been described. Such weighing will do in extreme cases, but no assayer should be without a first-class balance.

Any convenient unit divided into 1,000 parts may be used in the bullion assay. For gold assays the unit is usually one half gramme so divided, while for silver, being less valuable, one gramme is used. It is not safe to trust the weights of any maker, no matter how celebrated he may be, but the assayer should test their accuracy for himself.

Another source of error is a slight loss of gold on the cupel. This error may be corrected by cupeling a proof in the muffle at the same time with the assay. The proof is pure gold and silver, as near the composition of the assay as can be made. The loss of the proof is supposed to be equal to that of the assay and is to be added to its weight.

The manner of using the proof is as follows: First, consider what will be the average fineness of the assays being conducted. The preliminary assays will furnish the data. Let it be supposed that this average will be .950, weigh out nine hundred and fifty thousandths of pure gold, alloy it with two and a half its weight of silver, and cupel it in the muffle with the nine assays, boil with the same acid, and under exactly similar circumstances, heat to redness in a dry cup and weigh. It will generally be found to have increased in weight, owing to the surcharge being in excess of the mechanical loss. What the proof has gained in weight must be subtracted from the other assays; when many assays are to be made from the same mine, an alloy of copper, silver, and pure gold must be made up as nearly identical as can be with the composition of the bullion, and this alloy used as a proof. Of course a full unit must be employed in this case.

A third error may result from using an impure acid, causing a loss of gold, from its solubility in nitric acid containing chlorine. This error may be avoided by always having a little silver dissolved in the acid. It is too expensive and wholly unnecessary to employ chemically pure acid in the gold assay. Good commercial nitric acid, treated in the manner to be described, will answer every purpose. Acid of two grades of strength must be prepared from the strong acid, one of twenty degrees Beaumé, and one of thirty degrees. It is best to dilute all the acid to thirty degrees with distilled water, and to add a few drops of a solution of nitrate of silver. Let it remain twenty-four hours to settle, and add a few more drops of silver solution. If no cloudiness appears, the diluted acid is allowed to stand covered for a week, and the clear portion decanted from the slight precipitate of chloride of silver. One third of the acid is then diluted with distilled water to twenty degrees. The process of diluting is easily performed by the aid of a hydrometer. A portion of the acid is poured into a cylinder deep enough to float the hydrometer, which will sink to a certain point according to the density of the acid. The strength in degrees can be read on a scale on the inside of the stem.

Every assayer should possess a hydrometer and cylinder, and dilute his acid himself. The acid so prepared should be distinctly labeled, and the fact of its containing silver noted on the label. It should be used for no other purpose.

Still another error to be guarded against is the surcharge, which is the small amount of silver which always remains in the cornet, no matter how carefully the manipulations may be conducted. There are several tables computed to correct this. The finer the gold the greater will be the surcharge.

The following results were obtained by a series of careful experiments in the Paris mint, by weighing out accurately gold and silver, both absolutely pure, to represent the fineness written in the first column. The results in the second column show the surcharge when they are greater than the fineness, and the loss on the cupel when they are less. The assays were:

900	900.25	400	399.5
800	800.5	300	299.5
700	700.0	200	199.5
600	600.0	100	99.5
500	499.5		

Pure gold for proofs may be obtained in the manner described under the head of the chemistry of gold. The pure metal should be melted, rolled out thin, cleaned from oil, cut into shreds, and kept in a clean bottle for use.

There are a few points to be borne in mind in making the bullion assay to insure success. The alloy of gold and silver should not be rolled out too thin, as it is likely to be broken when this precaution is disregarded. The cornet must never be weighed without being heated to redness. Simple drying will not give correct results. In boiling with acid, the flasks should be turned on their sides at an inclination of 45° to prevent loss of acid in the event of sudden ebullition. A graduated measure should be used for the acid, that the amount put in each flask may be equal. Common water should never be used in washing the cornet, as chloride of silver is formed in the pores of the gold, which cannot be removed, and which being insoluble in acid remains in the cornet and gives incorrect results.

RETORTING GOLD AMALGAM.

For small operations, the retort used is a deep cast-iron vessel, shaped somewhat like a bowl. The top edge is planed level, and upon this fits a cover, also planed true, so that when put together, the two parts form a perfect joint. From the cover an iron tube rises and bends downward, at an angle of about twenty degrees from the horizontal. The cover is fastened by a clamp and set screw. A mixture of wood ashes and clay is prepared by mixing them into a thick paste with water. When all is ready the balls of amalgam are placed in the bowl, the mixture of ashes is put thickly around the edge, the cover fitted, clamp adjusted, and the whole firmly fixed by means of the set screw. All the superfluous luting is removed, and the retort placed in a furnace over a moderate fire. The end of the pipe must dip just below the surface of water placed in any convenient vessel; if the fire is kept well under control there will be no necessity for cooling the pipe. It sometimes happens that when the amalgam has been imperfectly cleaned, the gold will stick to the retort; this may be obviated by chalking the interior of the retort, or putting a piece of common writing paper under the amalgam balls. However, when the amalgam is clean and has been thoroughly worked over, the gold will come out easily.

A very convenient way to retort is to drive two small stakes into the ground, and to fasten a small iron rod to each, at a convenient height; upon this the retort is hung, and around it a fire of small wood built. When the retort has attained a dull red heat, and no more mercury distils over, the fire is put out and the retort allowed to cool; the cover is taken off and the bullion removed. If the amalgam has been properly cleaned, it will be found after retorting, to be metallic in appearance, and of a gold color. It is ready for the melting pot as soon as taken out.

It is never safe to open the retort before it is cool, nor will it stand being cooled in water. Many persons have done themselves great injury in their impatience to see the result of an important run, by opening the hot retort, and inhaling the poisonous mercurial fumes.

In extensive runs, when the clean-up is large, a retort of cast iron, made something like a gas-house retort, with movable front door, is set in brick work and furnished with a cooler surrounded by constantly changing water.

Inexperienced miners find it difficult to separate iron from amalgam, which is too often put into the retort without proper cleaning, in which case the bullion comes from the retort looking like soot; yet the management of amalgam is simple, and when once understood there need be no failure.

Many experiments have been made to clean improperly retorted gold bullion by the use of acids. This is nearly always attended with loss of gold or is inoperative. I once saw a miner in Mariposa County cleaning crude bullion just from the retort, by boiling in aqua regia—nitro-muriatic acid—after which he threw the acid away!!

Some miners wash amalgam as taken from the bags, first in diluted sulphuric acid, and then with nitric acid supposed to be pure.

It is almost needless to say that such treatment shows gross ignorance. It is better to properly clean the amalgam and to flux off any accidental impurity in the crucible.

GOLD IN CALIFORNIA.

Gold exists in nearly every county in California. To enumerate all the localities in detail would be useless. In the second report of this office, the subject of placer, hydraulic, and drift mining was very fully treated.

QUARTZ MINING.

To treat the subject of quartz mining in California with the fullness and completeness that its importance demands, would require more time and means than the State Mineralogist has now at his disposal; wherefore it has been thought best to defer the whole matter till his next annual report, in the hope that he will be able in the interim to collect such data as will prove of interest to the public at large, and of special service to the millman and miner. While so reserving this subject for future consideration, it may be observed that the business of quartz mining is in a very healthful and promising condition in this State. Purged of such elements of speculation as formerly entered into it, this industry is now being carried on with something of that system and careful attention to details that is deemed essential in the prosecution of other legitimate pursuits. The inordinate expectations of earlier times have been moderated, and economy has largely taken the place of lavish expenditure, while theories have everywhere been subordinated to practical experience, many valuable improvements having, meantime, been introduced into every department of the business. How large these gains have been is denoted by the fact that many abandoned mines are again being worked, while ores once rejected as worthless are now being reduced with profit. In some instances quartz rock is being mined and milled in California that pays on an average not over three dollars per ton, whereas twenty dollar rock was at one time considered too low grade to warrant its removal from the mines. While three dollar ore can, as a matter of course, be handled to advantage only where the conditions are exceptionally favorable, still, we have in this State such infinite quantities of four and five dollar ore that very rarely will it be found necessary to run on a much poorer grade. Although much of the gold in our California ores is found combined with sulphur, not until recently have effective means been adopted for fully saving these sulphurets, nor for a long time had any satisfactory process for their subsequent treatment been devised. All this is now changed or is undergoing a change that must result in a very great saving of the precious metal, a large percentage of which, under the old wasteful system, was lost.

In the mechanical as well as in the metallurgical branch of the business much progress has been made. While the stamp and mortar still holds its supremacy as an ore crushing implement, its province is being invaded by other appliances, some of which, having been continued in use after the most critical tests, may be expected to retain the favor that they have gained with the millmen. And so, of various other mechanisms that have already been adopted, or which are seeking recognition at the hands of the mining public.

For many years it has been the practice of Californians to interest themselves in the mines of Nevada, Arizona, Mexico, and other outside localities. But, with the improved condition of things at home, it may safely be predicted that very little local capital will hereafter seek investment beyond the limits of the State. This growing disposition on the part of our moneyed men to embark their means in the mines of California insures for quartz operations here an early expansion and a prosperous future. That the number of stamps now running in the State will be increased from sixty to eighty per cent within the next ten years seems highly probable, and that the business of quartz mining will hereafter see fewer losses and failures than have attended it in the past may be accounted altogether certain.

PRODUCTION OF GOLD.

Since the grand discovery of gold in California, which occurred January 19, 1848, the value of that metal produced in this State amounts, according to the authorities cited below, to $1,049,323,545, the product for 1884 being by us estimated on the basis of the average product of the preceding two years.

TOTAL PRODUCT OF GOLD IN CALIFORNIA.

Years.	Authorities.	Amount.
1846 to 1868 (inclusive)	W. P. Blake's Report on the Precious Metals, folio 21 (estimated)	$807,000,000
1869	Rossiter W. Raymond	20,000,000
1870	John Valentine	18,682,972
1871	Rossiter W. Raymond	16,167,484
1872	John Valentine	19,049,098
1873	Mining and Scientific Press (October 24, 1874)	18,052,722
1874	John Valentine	17,617,124
1875	John Valentine	16,326,211
1876	John Valentine	16,099,499
1877	John Valentine	15,237,729
1878	John Valentine	17,306,508
1879	John Valentine	18,190,973
1880	John Valentine	17,745,745
1881	John Valentine	17,166,674
1882	John Valentine	15,520,325
1883	John Valentine	13,841,297
1884	Estimated	14,680,806
Total		$1,078,685,167

This, if refined to pure gold and melted, would make about 2,968 cubic feet, and form a cube having an altitude of $14\frac{371}{1000}$ feet, nearly.

The following table, which covers the entire era of gold production in California, giving both the yearly and total output during that period, has been prepared for this report by Dr. Henry Degroot, a painstaking and generally accurate statistician. As will be seen, only round figures have here been employed, since, however, Mr. Valentine may be able to give with exactness the amount of gold received and transmitted by the express company of which he is Superintendent, to attempt the same precision in compiling a table of the total gold product of the State where the data is so uncertain and the means of collecting it so insufficient, would be to pretend to an accuracy not attainable in dealing with this class of facts:

DR. DEGROOT'S ESTIMATE.

Year.	Amount.	Year.	Amount.
1848	$5,000,000	1868	$23,000,000
1849	23,000,000	1869	22,000,000
1850	50,000,000	1870	21,000,000
1851	55,000,000	1871	18,000,000
1852	60,000,000	1872	20,000,000
1853	65,000,000	1873	19,000,000
1854	60,000,000	1874	18,000,000
1855	56,000,000	1875	17,000,000
1856	55,000,000	1876	17,000,000
1857	54,000,000	1877	16,000,000
1858	50,000,000	1878	17,000,000
1859	48,000,000	1879	20,000,000
1860	45,000,000	1880	19,000,000
1861	40,000,000	1881	18,000,000
1862	38,000,000	1882	16,000,000
1863	35,000,000	1883	15,000,000
1864	30,000,000	1884 (estimated)	16,000,000
1865	28,000,000		
1866	26,000,000		$1,160,000,000
1867	25,000,000		

HISTORY OF EARLY GOLD DISCOVERIES IN CALIFORNIA.

Early Fictions and Actual Discoveries.—The belief so generally entertained that the gold discovered at Sutter's Mill in 1848 was the first ever found in California, is erroneous, placers of limited extent having been met with at various points in the country long before that date. As to the early traditions which ascribed to this section of the Pacific Coast a marvelous wealth of the precious metals, they are not only apocryphal, but for the most part wholly fictitious, it having been the custom a few centuries since for the discoverers of new lands to magnify their importance by setting afloat stories of this kind. Thus, Sir Francis Drake, who, in 1579, visited this coast and entered the bay which now bears his name, on his return to England, gave such a glowing account of the country that Hakluyt, a historian of that day, in writing about it remarks that "there is no part of the earth here to be taken up wherein there is not a reasonable quantity of gold or silver"—this being said about the district lying adjacent to Drake's Bay, in which no sign of the precious metals has ever been found. This, then, was a sheer fabrication of the great navigator, unless, to be sure, an entire absence of gold and silver may be construed to constitute "a reasonable quantity" of these metals. Again, in a book published at Lorraine, about the time above mentioned, there occurs the following passage: "The soldiers of Vasquirus Coronatus, having found no gold in Vivola, in order not to return to Mexico without gold, resolved to come to Quivera (California), for they had heard much of its gold mines, and that Tatarraxus, the powerful King of that country, was amply provided with riches." Stories of this kind were rife during the period of the Spanish conquests, having been invented to stimulate the cupidity of the soldiery and encourage all to new adventures.

Of the placers discovered here in early times one was located near the Colorado River, San Diego County; this, the first found, having been discovered in 1775. The site of this find is embraced within the limits of what is now known as the Carga Muchacho mining district, located about fifteen miles a little north of west from Fort Yuma. Situated on a dry mesa, with no water nearer than the Colorado River, twelve miles distant to the southeast, it is not probable that this placer was ever worked much, though some gold has been gathered there of late years; the miners taking advantage of the little water afforded by the Winter rains, in that region very scanty. Some dry washing with machines has also been practiced at this locality. The quartz lodes, numerous in the neighborhood, were undoubtedly the primary sources of these placer deposits. These lodes are quite rich in gold, as is shown by the production made by the Yuma Mining Company, who put up a mill there several years ago, and had prior to June, 1882, taken out $167,000 from 14,000 tons of quartz. With even a moderate supply of water this placer, though not very extensive, could, no doubt, be worked with profit.

The next discovery of this kind made, occurred fifty-three years later at San Isidro, in the same county, gold diggings having afterwards been found on the upper waters of Santa Clara River, and still later in the San Fernando Mountains, both in Los Angeles County. These San Fernando diggings were worked steadily in a small way for twenty years, not having been wholly abandoned until the Spring of 1848. Here considerable gold dust was taken out, to the value, probably, of $150,000, or $200,000. From the other placers mentioned, however, very little was ever collected. Being by no means rich, and but scantily supplied with water, these could, in fact, be worked only in a limited way, and were incapable of paying large wages. Some ten or twelve years ago portions of the gold-bearing gravel in the San Fernando region were worked by the hydraulic process, but the operations not proving remunerative were, after a trial of several years, suspended. There is a talk now of new enterprises of this kind being undertaken in that district; it being the opinion of good judges that under present improved conditions, these gravel banks can be made to pay. A project is also at this time entertained of bringing water from Lake Elizabeth upon the ancient Santa Clara placer, which, with the supply so afforded, it is believed, would give profitable employment for many years to a considerable number of men. Gold gathering in a small way, conducted in some instances by dry washing is, and for many years past has been, carried on all through this San Fernando region, the merchants at Newhall and elsewhere in the vicinity buying small lots of it, for which they pay $17 50 per ounce. Colors, and in some cases, very fair prospects can be found in many of the ravines in this range and along Placenta Cañon, five miles from Newhall, where several small parties are engaged in gold washing, at which business they make good wages most of the year.

TABLE SHOWING FINENESS OF CALIFORNIA GOLD.

Compiled from notes made by John S. Hittell:

PLACER MINES.

Amador County.

Buena Vista	880 to 940
Butte Flat	880 to 920
Clinton	860 to 880
Drytown	860 to 880
French Hill	920 to 930
Humbug	920 to 930
Irishtown	860 to 880
Jackson Creek	860 to 880
Lancha Plana	880 to 940
Mokelumne River	860 to 870
Red Hill	920 to 930
Slabtown	860 to 880
Sutter Creek	840 to 860
Stone Creek	850
Tunnel Hill	920
Willow Springs	860
Brown's Flat	920 to 925
Douglasville	930 to 935
East Columbia	905 to 935
East Columbia (Lower part main gulch)	937
East Columbia (Upper part main gulch)	920
Knapp's Ranch	940 to 950
Matelot Gulch	930
Pine Log	890 to 895
Rensomville	945
Rio Vista	925
San Diego Gulch	940
Sawmill Flat	920
Springfield Flat	950 to 965
Three Pine	935
Under lava beds at Gold Hill	968
Yankee Hill	917 to 930

Butte County.

Blue Lead	950
Butte Creek	880
Bangor	910
Cherokee	970
Dogtown	880
Dry Creek	925
French Creek	870
Forbestown	870 to 880
Forbes Ravine	898
Hansonville	925
Holt's Ravine	935
Honcut	910 to 925
Kimshew	920
Main Feather River	890 to 900
Middle Fork Feather River	890
Morris Ravine	918 to 920
Mooreville	890
Nimshew	900
North Fork Feather River	880
N. S. Flat	910
Oregon House	900
Ophir Flat	875
Oroville	920
Prairie House	925
Rancheria	920
South Fork Feather River	892
Thompson's Flat	940
Walker's Plains	920
Willow Creek	900
Wyandotte	900
Yankee Flat	930 to 950

Calaveras County.

Albany	892
Average	900
Balaklava Hill	900 to 910
Byrne's Ferry	860
Calaveras River	895
Campo Seco	845
Cave City	900
Chile Gulch	890
Central Hill	780 to 785
Chichi	935 to 940
Corral Flat	910
Corral Hill	955
Douglas Flat	900
El Dorado	880 to 890 to 895
Empire Gulch	870
French Gulch	870 to 875
Gravel Ridge	908
Humbug Hill	928 to 940 to 947
Indian Creek	870 to 880
Jackson	935 to 945
Mokelumne Hill	930
Murphy's	888
Old Channel	905
Old Gulch	895
O'Neil's Creek	911
Pennsylvania Gulch	908
Owlsbarron Flat	900
Red Hill	840 to 850
Rich Gulch	895
Salt Spring Valley	700
San Andreas	900
San Antonio	850 to 884
San Domingo	852
Snake Gulch	875 to 880
Tunnel Hill	883
Texas Gulch	895
Union Claim	942
Vallecito	900 to 945
Vallecito Hill	940
Vallecito Flat	900 to 910
Waite's Flat	940
Wm. Holmes	900

El Dorado County.

Aurum City	870
Bottle Hill	888
Brownsville	900 to 800 to 960
Buckeye Hill	910
Buckeye Flat	850
Big Cañon	857
Cañon Creek	885
Carson Creek	910
Centerville	927
Coloma	880
Cosumnes	856 to 880 to 810
Clay Hill	915
Coon Hill	965
Coon Hollow	910 to 970
Cedarville and Mount Auburn	800

Deer Creek	895
Divide, between American and Weber Creek	850 to 900
Dogtown	825
Dross Ravine	850
Dry Creek	850
Empire Ravine	885
Empire Cañon	860 to 880 to 890
Fairplay	800
French Creek	820
French Town	840
Georgetown	860 to 885
Gold Hill	900 to 890
Grizzly Flat	735 to 650 to 865
Green Valley	900
Grizzly Gulch	850
Hangtown Creek	900
Hermitage Ranch	950
Illinois Cañon	890
Immigrant Ravine	910
Indian Diggings	925 to 900
Indian Creek	890
Indian Hill	950
Johntown	885
Kelsey	870
Kentucky Hill	890
Latrobe	890
Matthews' Creek	890
Manhattan Creek	940
Missouri Flat	938
Missouri Cañon	775 to 880
Mount Gregory	830
New York Ravine	915
Otter Creek	880 to 830
Oregon Cañon	890
Pleasant Valley and Newtown	910
Plunkett's Ravine	905
Quartz Cañon	840
Quartz Hill	870
Reservoir Hill	910 to 940
Rich Bar	885
Rock Creek	890
Shingle Springs	852
Smith's Flat	975
Spanish Hill	900 to 950 to 987
Spanish Camp	855
Spanish Dry Diggings	750 to 880
Spring Hill	875
Stillwagen's	675
South Fork of American River	900 to 890 to 875
Slate Creek	850
Sugar Loaf	968
Uniontown	880
Webber Creek	888 to 890
White Rock Hill	965
West Cañon	890

Kern County.

Kern River	659

Mariposa County.

Black Creek	848
Blue Gulch	892
Coulterville, Bear Valley	830 to 840
Flyaway	862
Gentry's Gulch	895 to 898
Horseshoe Bend	855
Maxwell's Creek	861
Merced River	850 to 860
Peñon Blanco	860
Sherlock's Creek	860
Sheldon	760
Solomon's	862

Nevada County.

Alpha	917 to 968 to 908 to 965
American Hill	875 to 885 to 905
Arkansas Cañon	936
Bear River	870 to 878 to 900
Blue Tent	885 to 925
Beckville	848
Birchville	942
Borrjers Ranch	847
Bourbon Hill	840 to 837 to 844
Brandy City	870
Brush Creek	958 to 961
Brown's Hill	906
Buckeye Hill	877
Canada Hill	545
Cedar Ravine	865
Cement Hill	840 to 852
Chalk Bluff	960 to 970 to 976
Christmas Hill	980
Cherokee	910 to 920
Columbia Hill	922 to 961
Colton Hill	890 to 964
Cooley Hill	964
Coyote Hill	850 to 860
Crumbeck Ravine	866
Deer Creek	949 to 950 to 955
Rough and Ready	875 to 880
Diamond Creek	845 to 850 to 890 to 906
Eagle Ravine	848
Eureka	831 to 825 to 835 to 870 to 853
Fall Creek	878 to 880
French Garden	820
French Corral	840
Gold Hill	965 to 970
Gold Cañon	920
Gold Flat	837 to 815 to 831
Gopher Hill	884 to 825 to 925 to 936
Greenhorn	865 to 870
Green Mountain	916
Grizzly Cañon	810
Hunt's Hill	912 to 935 to 913 to 930
Humbug	920 to 953 to 885 to 923
Hitchcock Ravine	825
Illinois Ravine	861
Jackass Flat	859
Jefferson Flat	874
Jefferson Hill	911
Jones' Bar	884
Kanaka Creek	875 to 880
Kansas Hill	836
Kentucky Flat	870
Lawson Flat	877
Liberty Hill	896 to 908
Little York	960 to 892 to 910
Little Deer Creek	845 to 850
Lost Hill	885 to 890
Lost Ravine	870 to 903
Lowell Hill	904
Long Hollow	834
Manzanita Hill	820 to 830
Miles' Ravine	860
Middle Yuba	880
Missouri Bar	883 to 884
Mount Oro	872
Moore's Flat	860 to 875
Montezuma Hill	865
Mosquito Creek	790 to 800
Mud Flat	818
Myers' Ravine	860 to 870
Native American Ravine	884
Nevada City	815 to 840
Newtown	825

North Yuba	890
Omega	950 to 975
Orleans Flat	895 to 910
Oregon Hill	875 to 890
Osborne Hill	841
Peck's Ravine	828 to 833
Phelps' Hill	913 to 920
Pleasant Valley	898 to 904
Picayune Point	850 to 890
Quaker Hill	922 to 960
Randolph Flat	920
Rattlesnake	810
Red Dog and You Bet	903 to 860 to 875 to 930
Relief Hill	931
Remington Hill	920
Rock Creek	869 to 870
Round Mountain	834 to 879
Rush Creek	840 to 850
Sailors' Flat	870 to 875
San Juan North	960
Selby Hill	840 to 865 to 814
Selby Flat	840 to 845
South Yuba	870 to 875
Scott's Flat	922 to 940
Shady Creek	900 to 910
Slate Creek	814
Snow Point	880 to 885
Steep Hollow	900 to 903
Sweetland	900 to 930
Scotchman's Creek	897 to 922
San Juan, Columbia Hill, and Humbug	912 to 935
Timbuctoo	940 to 950
Thomas' Flat	854
Ural	811 to 820
Virgin Flat	886
Washington	870 to 886
Walloupa	852 to 880 to 910
Woods' Ravine	855 to 845
Wet Hill	855 to 875
Wolf Creek	910 to 829 to 825 to 800
Woolsey's Flat	910
Wilcox Ravine	845 to 855
You Bet (blue gravel)	890 to 919
You Bet (red gravel)	907 to 984
Yankee Hill	917

Placer County.

Antelope Ravine	770
Antone	900 to 910
Auburn Ravine	810
Bath	870 to 910
Bear River	900 to 910 to 930
Bear Valley	914
Blue Gulch	925
Blue Lead	930 to 935 to 940 to 944
Bird's Flat	893
Bird Valley	830 to 890
Brushy Cañon	925
Burnt Flat	865 to 870
Cañon Creek	950
Canada Hill	900 to 910
Cedar Company	965
Colfax Ravine	900
Damascus	900 to 890
Deadwood	930 to 945
Devil's Basin	945
Doten's Bar	870
Doty's Flat	750
Doty's Ravine	750
Dutch Ravine	810
Dutch Flat	934 to 950 to 940 to 970
Dutch Flat Ravine	930
El Dorado Cañon	870 to 935
Elizabethtown	860
Forest Hill	880 to 890
Gold Run	950 to 975
Green Valley	920
Grizzly Flat	905
Humbug Cañon	890 to 894
Huyck Company	945
Illinoistown	794
Indiana Hill	925
Iowa Hill	900
Last Chance	915 to 920
Ladies' Cañon	750 to 870
Long Cañon	930
Lost Camp	940
Mad Cañon	870
Michigan Bluff	940 to 970
Michigan Flat	925 to 970
Minna Flat	890
Middle Fork of American	870 to 880 to 890
Millertown	800
Miller's Defeat	916
Miners' Ravine	760
Nary Red	916 to 935
Nevada Company	945
North Fork of American	870 to 875 to 910
North Ravine	790
Ophir	740
Paradise	830 to 840
Pine Flat	800
Red Hill	960 to 970
Roach Hill	918
Rock Creek	910
Rich Flat	915
Rock Spring	690
Secret Cañon	900 to 910
Secret Town	825 to 860
Secret Ravine	800
Squires' Cañon	960 to 965
Taylor Company	965
Van Cliff	900 to 910
Virginiatown	775
Yankee Jim	900

Plumas County.

Jamison	860
Laporte	940 to 945
Onion Valley	900
Poorman's Creek	860 to 880

Sierra County.

Alleghany	900
American Hill	935 to 950
Bald Mountain	915 to 956
Balsam Flat	880
Cañon Creek	880
Cedar Grove	930
Chaparral Hill	905
Chipps' Flat	880
City of Six	900
Chandlerville	920 to 940
Cold Cañon	918
Craycroft	880
Deadwood	840
Downieville	885
Eureka	840 to 905
Excelsior	905
Feather River	870
Fir Cap (Fir Gap)	828
Forest City	900
French Ravine	800

Green Gulch	$38 00
Goodwin	50 00
Hite's Cove	$25 to 30 00
Louisiana	$6 to 8 00
Mariposa	9 00
Marble Springs	25 00
Maxwell Creek	$8 to 9 00
McKenzie	20 00
Mount Ophir	$8 to 12 00
New Britain	20 00
Nonpariel	$13 to 30 00
Princeton	$16 to 18 00
Potts	$50 to 60 00
Sherman	$60 to 100 00

Nevada County.

Gold Hill and Rocky Bar	$80 00

Placer County.

Empire	$8 00
Golden Rule	12 00
Green Emigrant	10 00
Schnabel's	6 00
Stewart's Flat Mining Company	15 00
Wells	12 00

Plumas County.

Bullfrog	$8 00
Callahan's	12 00
Crescent	$12 to 15 00
Eureka Plumas	12 00
Indian Valley	18 00
Premium	19 00
Plumas Mill	$8 to 10 00

Sierra County.

Independence	$10 00
Keystone	17 00
Oak Flat	$15 to 23 00
Primrose	15 00
Reis	16 00

Tuolumne County.

App.	$15 00
Anthrac	14 00
Argentum	125 00
Big Basin	$40 to 50 00
Burns	15 00
Carson Creek (portion of vein 60 ounces silver per ton)	$7 to 8 00
Columbia	11 00
Davidson	40 00
Eagle	$18 to 30 00
Golden Rule	$10 to 12 00
Gillis	25 00
Heslep	10 00
Kimball (extension)	10 00
Mount Vernon	100 00
Mooney & Co.	4 75
Mother lode at Rawhide	$8 to 70 00
Old Gelsen mine	50 00
Rawhide	$7 to 8 00
Small mine, Knight's Creek	50 00
Starr King	15 00
Shawmut	18 00
Summit Pass	8 00
Summit	$10 to 80 00
Talc Lode	$5 to 6 00

Yuba County.

Deadwood	$30 00
Dannenbroge	$15 to 20 00
Honeycomb	7 00
Pennsylvania	$15 to 20 00
Polecat	12 00
Rattlesnake	18 00

67. GRAPHITE. Etym. "*I Write*" (Greek). Plumbago, Black Lead, etc.

Graphite, when pure, consists of carbon; but it is comparatively seldom found pure, being generally mixed with earthy matters, from which it can be freed by mechanical means. The operation is, however, expensive and not always satisfactory, for which reason low grade graphite has but little value. There are a number of localities in the world (Cumberland, England, Ural Mountains, Russia, Ceylon, Madagascar, and elsewhere), where a fair quality is obtained in abundance, from which the market is supplied. No graphite of good quality has been found in California, although an inferior article is not uncommon in the State. Molybdenite is frequently mistaken for it.

The following constitute the principal places where graphite has been found in California: One mile north of the town of Sonora, and at Gold Springs, in Tuolumne County; near Fort Tejon, Kern County; on the border of Tomales Bay, in the Coast Range; near Summit City, Alpine County; and at various localities in Sonoma, Marin, Plumas, and Sierra Counties. A heavy deposit of this mineral is said to have been discovered quite recently at Tejunga, twenty-five miles from the City of Los Angeles, and twelve miles from the line of the Southern Pacific Railroad; and another at Borer Hill, in the northeastern part of Fresno County. With so many discoveries reported, but little graphite has yet been mined in this State. Only on the Sonora deposit has much work been done, and from this alone has even so much as a few tons of the mineral been extracted; this neglect being due to a variety of causes, such as the impure character of the mineral, cost of mining and transportation to market, etc. This Sonora deposit, which was discovered in 1853, was afterwards, under the name of the Eureka Plumbago mine, worked in an inefficient and limited way for a number of years, about 1,000 tons of plumbago having been extracted altogether. There being little demand for the article in California, nearly the whole of it was shipped to England, France, and Germany, and there sold at an average price of $100 per ton, which it was at the time claimed afforded a net profit of $50 per ton. The cost per ton of production and marketing here was about as follows: Mining and preparing the material, $5; sacks, $2; freight to Stockton, $9; freight to San Francisco, $1 50; freight to Liverpool, $14; commissions, storage, insurance, etc., $18 50. Not for the past fifteen years has anything been done at this mine; pretty good evidence that operations on it could not be made to pay. The trouble consisted, no doubt, in the difficulty of obtaining here a merchantable article without incurring too much expense, this mine containing a large mass of low grade, with only a small per cent of pure mineral. From the accounts given of them, several of the other deposits found in the State may be expected to yield much larger quantities of marketable graphite than this mine near Sonora, and as some of them are located near railroads, they will probably meet with early and profitable exploitation.

The principal uses of graphite are the manufacture of the so called lead pencils; as an anti-friction substance; stove polish; the manufacture of crucibles; and as a pigment, which is claimed to be very durable. This paint is specially useful as a protection for smoke stacks against acid fumes. For the three latter purposes, the graphite refined from the impure mineral serves very well, and it is probable that for such purposes the California deposits will in the future be largely utilized. According to Blake, it is found twenty miles above Big Tree Grove, in crystalline scales (probably molybdenite); and at Knight's Valley, Sonoma County. The following localities are represented in the State Museum: (929) is from Sonora, Tuolumne County; (1895) from Guerneville, Sonoma County; (3746) from near Pine Flat, Sonoma County.

Gray Copper—see Tetrahedrite.

68. GROSSULARITE. Etym. *Gooseberry* (Latin).

Lime garnet is quite abundant in California, especially in the southern counties, where it has often been mistaken for tin by Cornish miners who have seen it, and several tin excitements have had their origin in this mistake. It is found also with copper ore in the Roger's claim, Hope Valley, El Dorado County (Dana), and, as in the specimen No. 2190, in the State Museum, with datholite, near San Carlos, Inyo County.

69. GYPSUM. Ancient name—Alabaster, Selenite, Satin Spar, Plaster of Paris.

Gibsonville	900 to 936
Hepsidam	900
Hopkins' Creek	915
Howland Flat	900 to 909 to 919
Kanaka Creek	860
Ladies' Cañon	884
Middle Yuba	875
Monte Christo	905
Minnesota	880
Near Sierra Buttes	920
Nebraska (blue lead)	935
Nelson	887 to 906
Oregon Creek	830
Poker Flat	890
Pine Grove	920
Potosi	912 to 919
Poorman	910
Port Wine	935
Ravines near Laporte	900
Richmond Hill	910
Rock Creek	900
Sawpit Flat	910
Slate Creek	900 to 880
Smith's Flat	825
Spanish Ranch	945
St. Louis	900 to 925
Sweet Oil Diggings	875
Union Company	870
Washington Hill	906
Wet Ravine	825
Whisky Diggings	905
Young America Flat	800 to 820

Tuolumne County.

American Camp	850
Cooper's Flat	735 to 825
Columbia	930 to 950
Golden Rule	800
Jamestown	890 to 900 to 815 to 820
Montezuma	900
Poverty Hill	890 to 900
Shaw's Flat	927 to 930
Springfield	930 to 960
Sonora	878
Somerville	780
Sugar Pine	900 to 920
Rawhide Ranch	850

Yuba County.

Brownsville	890
Mooney Flat	900 to 940
Ousely's Bar	950
Parks' Bar	960
Timbuctoo	930 to 962

QUARTZ MINES.

Amador County.

Coney	878
Fogus	780
Hinckley	800
Jackson	810
No. 1. Jones at American Camp (with lead)	540
No. 2. Jones at American Camp	750
Kelly & Stevenson	820 to 810
Keystone	830
Oneida	830
Paugh's	810 to 830
Plymouth	770 to 772 to 840
Seaton	730
Shanghai	870
Spring Hill	820 to 824
Tellurium	750

Butte County.

Mount Hope	860
Nesbit	890

Calaveras County.

Angel Quartz Company	900
Bovee	908
Dr. Hill	900
French Gulch	803
Flanigan	910
Isabel	875 to 880
Morgan	910
Quail Hill	560
Stickles	885
Union	904 to 908
Woodhouse	820

El Dorado County.

Clipper Hill	900
Dane's	800
Eagle	650
Gray's	895
Georgia Slide	900
Hermitage Ranch	887
Independence	796
Knox	650
Steeley	650

Mariposa County.

Bear Creek		877
Goodwin		895
Hite's Cove		814
Hornitos Creek		650 to 660
Louisiana		652
Mariposa		700 to 800
Mariposa	Josephine lode.	869 to 875
Princeton	Josephine lode.	750 to 820
Pine Tree	Josephine lode.	780 to 790
Ryerson	Josephine lode.	918
Wright		738

Nevada County.

Allison Ranch	850 to 860
Bear River	803
Ben. Franklin	808
Cambridge	820
Canada Hill	730
Eureka	850 to 852
Empire	800
East End	846 to 856
Forest Spring	810
Gaston Ridge	819
Gold Hill	850 to 860 to 875
Goodyear Company	840
Illinois	854
Ione	815
Jim	827
Lucky	817
Merrimac	817
Murphy	800
Nevada Company	830 to 859
North Star	852
Osborne Hill	760 to 775
Potosi	816
Pacific	845
Rattlesnake	800
Rocky Bar	853

Shanghai	860
Shamrock	799
Sneath & Clay	823
Union Hill	822
Upham	821
Ural	802 to 807
Union Jack	811 to 823
Washington	860
Whigham	806
Wyoming	798 to 819

Placer County.

American Bar	860
Ophir	690
Rugh	630
Schnabel's	688

Sierra County.

American Hill	877 to 886
Eureka	875
Independence	866
Ironside	900
Keystone	933
Mammoth	870
Oak Flat	780 to 800
Reis	860
Rough and Ready	900
Sierra Buttes	865
Union	823

Tuolumne County.

Big Basin	600 to 785
Bald Mountain	930 to 950
Heslep	775
Mount Vernon	860 to 894
Reist	790
Table Mountain	908 to 950
Rawhide	830
Talc Lode	600 to 785

Yuba County.

Dannenbroge	860 to 900
Jefferson	840
Pennsylvania	840
Sweet Vengeance	880

TABLE SHOWING YIELD PER TON OF CALIFORNIA QUARTZ MINES.

Compiled from notes made by John S. Hittell:

Amador County.

Bunker Hill	$10 00
Coney	$13 to 13 50
Craft's	15 00
Golden Eagle	15 00
Hazard	12 00
Hinckley	12 00
Kelly & Co.	14 00
Mitchell	60 00
Oneida	17 00
Paugh's	10 00
Pioneer	40 00
Plymouth	8 00
Railroad	15 00
Seaton	8 00
Shanghai	32 00
Sirocco	15 00
Spring Hill	8 00
Van Tromp	100 00
Vaughn	10 00
Webster	7 00

Butte County.

Bateman	$30 to $40 00
Forbestown	20 00
Genesee	18 00
Mexican	10 00
Rare Ripe	18 00
Round Valley	22 00
Shakespeare	10 00
Spring Valley	$10 to 18 00

Calaveras County.

Albion	$6 00
Angel Q. M. Company	$8 to 15 00
Bovee	$9 to 10 00
Badger and Eureka	$12 to 15 00
Chaparral Tunnel	240 00
Crispin	20 00
Ella	8 00
Fisher's	7 00
Grizzly	$8 to 10 00
Harris	5 00
Mina Rica	$35 00
Morris	50 00
Mosquito	7 00
Reserve	100 00
Rocky Bar	25 00
Skull Company	$30 to 35 00
Santa Cruz	300 00
South Carolina Co.	$10 to 12 00
Thorpe's	10 00
Union Mine	23 00
Woodhouse	$10 to 14 00

El Dorado County.

Alpine	$72 00
Clipper	15 00
Collins	15 00
Cosumnes	11 00
Eppley	50 00
Independence	30 00
McDowell	3 50
Montezuma	10 00
Manning	30 00
Pacific	15 00
Persevere	15 00
Pocahontas	15 00
Plymouth	18 00
Rosecrans	12 00
Shepard	25 00
Stillwagen	25 00
Woodside	30 00

Mariposa County.

Adelaide	$8 00
Black	40 00
Benton Mills	29 00
Calico	20 00
Cherokee	35 00
Coward	40 00
Crown Lead	9 00
Derrick	$20 to 30 00
Epperson	$9 to 13 00
Ferguson	25 00
Flanigan	35 00

This mineral is a hydrous sulphate of lime. ($CaO, SO_3+2 HO$.)

Sulphuric acid	46.5
Lime	32.6
Water	20.9
	100.0

H=1.5—2. Sp. gr.=2.314--2.328. Color: white, gray, pink, yellow, blue, and sometimes almost black; transparent to opaque. When it is fine grained and compact it is called Alabaster, from "Alabaster" or "Alabastra," the ancient name of a box for holding perfumes and ointments; whether the box was named from the stone, or the reverse, is uncertain. Alabestrites, from which these boxes were made, was aragonite, or stalagmite, probably the variety described under the head of onyx marble. Gypsum in transparent plates, like mica, is called *selenite*, from the Latin "selenitis," the moon; the word being of Greek derivation: and when fibrous *satin-spar*.

Gypsum is employed in the arts as a cement (Plaster of Paris), and as a fertilizer. For the latter purpose it must in time be extensively used on the lands of California, now being rapidly exhausted. The farmers will some day awake to the fact that they cannot continue to harvest crop after crop from their lands without returning something to them, and the day is not far distant when fertilizers of all kinds will be used and not wasted as at present. Plaster of Paris is made by calcining pulverized gypsum at a low heat in iron kettles, by which the water is driven off. When so prepared, it has the remarkable and useful property of hardening again when water is added. When calcined with alum a harder cement is formed, "Keene's." When borax takes the place of alum it forms "Parian;" when pearl ash, "Martin's cement." Stucco is Plaster of Paris mixed with weak glue. Plaster of Paris is used with lime for hard finish plastering, and for making imitation marbles, for filling in between floors, and in other useful ways.

In the manufacture of bay salt, extensively produced on the shores of San Francisco Bay, and described in the second annual report of the State Mineralogist, sulphate of lime (gypsum) deposits from the sea water in the tanks. This deposit at the works of the Union Pacific Salt Company is estimated by Mr. Winegar to be over 1,000 tons per year. This could be gathered, ground, and washed to remove the salt, in which condition it would be valuable to sow on the lands as a manure. It is a question if there is another locality where so large a quantity of a valuable fertilizer would remain so long unused. At the other salt works the same material forms in proportion to the quantity of salt produced. The following California localities of gypsum are given by Blake:

Los Angeles County, in the Great Basin, near the entrance to the Soledad or "New Pass." San Diego County, along the banks of Carizzo Creek, and on the slope of the Desert. Tulare County, at the vein of stibnite in crystals. Nevada County, near the Truckee Pass, in beautiful stellar radiations, from half of an inch to three inches in diameter—(Cabinet of C. W. Smith, Grass Valley). Fine specimens are brought from the Ojai Ranch, Ventura County. It is found also in the mountains of the Arroyo Grande, San Luis Obispo County. The following localities are represented in the State Museum: (362.) Lockwood Creek, Los Angeles County. (667.) Monterey County. (2268.) Near Breckenridge, Kern County. (3726.) Near Hill's Ferry, Stanislaus County. (5018.) Posa Creek, Kern County.

ALABASTER.

Arroyo Grande, San Luis Obispo County. Los Angeles County (Blake). Point Sal, Santa Barbara County (6051).

SELENITE.

In large slabs, Soledad Cañon, Los Angeles County.
(354.) Lockwood Creek, Ventura County.
(799.) Santa Barbara County.
(957.) Near Dos Palmas Station, Southern Pacific Railroad, San Diego County.
(1260.) Robinson's Ranch, Lake County.
(1721.) In large slabs, near Susanville, Lassen County.
(2890.) Buena Vista, Kern County.
(3699.) Colorado Desert, San Diego County, five miles west of Volcano Station, Southern Pacific Railroad.
(4089.) San Emidio antimony mine, Kern County.
(4465.) Bear Valley, Mariposa County.
(4464.) Near Modesto, Stanislaus County.
(4672.) Calico, San Bernardino County.
(4765.) Near Gilroy, Santa Clara County.

SATIN SPAR.

(1847.) White River, Tulare County.
(4361.) San Bernardino County.

The deposit in Santa Barbara County (6051), represented to be of great excellence and very extensive, possesses the further advantage of being located within two miles of Point Sal, a shipping station on the coast for this portion of the county. This gypsum is of the white or Nova Scotia variety, being a kind well suited for making plaster of Paris, and which is said to occur abundantly at only a few other points in the United States.

Lucas & Company, proprietors of the Golden Gate Plaster Mill, in San Francisco, having leased this Point Sal gypsum bed for a long term of years, are now working the same actively, over one thousand tons of the raw material having been sent to their mill and manufactured into plaster of Paris. The article made by this firm is preferred to the best imported; plaster, like all these calcareous products, owing to the readiness with which it absorbs moisture, being greatly deteriorated by a long sea voyage. Formerly all the plaster consumed on this coast was imported, but since the Golden Gate Mill commenced operations, about ten years ago, importations have fallen off heavily, and will probably be still further diminished hereafter.

The imports of plaster of Paris at San Francisco have been as follows:

BARRELS AND SACKS.

1874	19,176	1879	5,400
1875	22,782	1880	3,200
1876	14,918	1881	5,850
1877	14,487	1882	4,777
1878	11,038		

Of late, prices have been low, being at present quoted at $2 50 and $3 per barrel.

The Santa Barbara deposit, above alluded to, if of the extent and kind represented by the local press, would seem to be the most important gypsum find that has yet occurred in California, being of easy access and located in a section of country where this mineral will be likely to come into large use as a fertilizer. Gypsum, found at a point about ten miles from Los Angeles, has been taken to that city, ground in the mill there, and on being applied to the land showed excellent fertilizing properties. The gypsum beds of Kern County extend along the foothills from Caliente to Long Tom, a distance of about thirty miles. Though occurring at intervals along so great a linear extent not much is known as to the quantity of the mineral here, no work having been done on these beds. Heavy beds of gypsum are reported in San Bernardino County at a point forty miles south from the county seat and fifteen from the line of the Southern Pacific Railroad.

For a number of years prior to the Santa Barbara discovery, the mills in this city procured their supply of gypsum for making plaster of Paris from Lower California, where an article suitable for this purpose can be readily obtained, ships being able to come within a short distance of the deposit.

70. HALITE. Etym. *Salt* (Greek). Common Salt.

The manufacture of salt was described in a special paper in the second annual report of the State Mineralogist. Since that report was published, several new salt springs have been discovered, and in sinking wells for petroleum, salt water frequently rises. The following is an analysis of a sample of water, No. 1936, from Placer County, near the Clipper Gap iron mines:

Solid matter, per gallon			17.65 grains
Silica, per cent	.58	By weight, grains	.102
Sulphate of lime, per cent	.53	By weight, grains	.093
Carbonate of lime, per cent	53.55	By weight, grains	9.450
Chloride of sodium (salt), per cent	45.34	By weight, grains	8.005
	100.00		17.650

Magnesia, oxide of iron, and alumina, traces.

The following is a statement of the production of salt in Alameda County, since the publication of the second annual report:

1882, about 35,000 tons; 1883, about 33,000 tons, most of which is still on hand at the works—at least 35,000 tons—some having been left over from 1882. No new companies have been started since 1882.

A. B. WINEGAR,
Union Pacific Salt Company.

71. HEMATITE. Etym. *Blood* (Greek). Hæmatitis, Specular Iron, Micaceous Iron, Red Hematite, Sesquioxide of Iron. (Fe_2O_3.)

Iron	70
Oxygen	30
	100

The name comes from an early historical period, being mentioned by Theophrastus, Pliny, and other ancient writers. Color and streak, bright red; translucent in thin fragments. B. B. on ch., infusible, but becomes magnetic; soluble in muriatic acid; these tests serve to distinguish it. It is a valuable iron ore, and is rather common in California, with other ores of iron.

CALIFORNIA LOCALITIES.

The variety, specular iron, occurs at Mumford's Hill, Plumas County (Edman); in large masses at Light's Cañon, Plumas County (Blake); near Shasta City, Shasta County (Dana). It is represented in the State Museum by the following specimens:

(87.) Ione Valley, Amador County. (1606.) (red) Owens' River Valley, Inyo County. (1860.) Clipper Gap iron mine, Placer County. (1861.) (ochrous) Clipper Gap iron mine, Placer County. (1896.) Kelsey Tunnel, fourteen miles southeast of Crescent City, Del Norte County. (1937.) Red Hill, Placer County. (2336.) Alameda County. (2833.) (earthy) Monitor, Alpine County. (2285.) (micaceous) Feather River, near Oroville, Butte County. (3367.) Near Campo Seco, Calaveras County. (3652, 3760.) San Andreas, Calaveras County. (3761.) Near St. Helena, Napa County. (3766.) Big Trees, Calaveras County. (3773.) Nevada County. (4356.) Diamond Springs, El Dorado County. (4652, 4987.) Near Jackson, Amador County.

72. HESSITE. Etym. *Hess*, Russian chemist. Telluride of Silver.

A single specimen was obtained in 1854, near Georgetown, El Dorado County. It had been washed out from the gold drift, and the parent vein has never been found (Blake).

Hornblende—see Amphibole.

Hornsilver—see Cerargyrite.

Horseflesh Copper Ore—see Bornite.

Hyalite—see Opal.

73. HYDROMAGNESITE.

A mineral, supposed to be hydromagnesite (no analysis), is found in the serpentines on the peninsula of San Francisco, and elsewhere in the State. It is represented by specimen No. 1320, in the State Museum.

Iceland Spar—see Calcite.

Idocrase—see Vesuvianite.

Idrialite—see Petroleum.

Ilmenite—see Menaccanite.

Iodide of Mercury—see Coccinite.

Ionite—see Mineral Coal.

74. IODINE. Etym. *Violet* (Greek).

Iodine is one of the elements resembling chlorine and bromine. It was discovered by accident in 1812 by M. de Courtois, while manufacturing saltpeter in Paris. In decomposing the ashes of seaweed to obtain soda he discovered this substance, which corroded the metallic vessels in which the operation was conducted. The chemists Clement and Desormes, who first examined it, found that at a low temperature it became a violet colored gas; from this they named it "*Iodine.*" Iodine, like chlorine and bromine, has a strong affinity for silver; advantage was taken of this in the early history of photography. So combined, it is found in nature as iodyrite, or iodide of silver, discovered by Vaquelin soon after the element became known.

Iodine exists in many marine plants and animals, in mineral waters, and in a few minerals, notably with nitrate of soda and salt. It is largely manufactured in Scotland from the seaweed abundant on the Scotch and Irish coasts. The weeds are thrown up on the beach and dried in the sun, after which they are burned, forming kelp. This is lixiviated and the solution concentrated by evaporation, the useful salts which crystallize out being removed from time to time. The dark colored liquors which remain are acidulated with sulphuric acid, and then heated with bin-oxide of manganese, in a leaden retort set in brick and connected with a series of condensers, in which the sublimed iodine collects. The apparatus may be found figured in "Graham's Elements of Chemistry," London, 1850, vol. 1, fol. 492, and in other works on technical chemistry. This process is mentioned here because there is reason to think that iodine is more abundant on the Pacific Coast than is generally supposed. Dr. Trask found free iodine and bromine in the serpentine rocks at Point Lobos, San Francisco. ("Report on the Geology of the Coast Mountains, etc., J. B. Trask, State Geologist, 1854," fols. 26 and 92.) About seventeen years ago I made an analysis of mineral water containing a large quantity of iodine. The sample was furnished by Mr. Fargo, of San Francisco, who has since informed me that the spring from which it was taken was at the entrance of Grizzly Cañon, Lake County, five or six miles from Wilbur Springs. In a letter by Dr. John A. Veatch, quoted in the third annual report of the State Mineralogist, 1883, fol. 17, he writes: "Nothing of much importance presented itself until reaching the saline district, about eighty miles south of Red Bluff. It is on one of the branches of Stony Creek. Valuable salt springs exist here. The waters contain the borates in minute quantities, and one spring was remarkable for the enormous proportion of iodine salts held in solution." I have long suspected that the mother liquors of the borax works in California and Nevada contained iodine, and have it still in mind to examine them in the near future. The recent discovery of nitrate of soda in California and Nevada adds to the likelihood of finding iodine. Mineral water containing iodine, but no objectionable minerals, must of necessity constitute a valuable medicinal agent in the hands of medical men familiar with its analysis. And here it is proper to call attention to the importance of having an official guide-book to the mineral springs of the State, containing full and careful analyses of all the known springs, made in the laboratory of a State institution, and at the public expense, the accuracy of which could not be questioned, as those made in the interest of the proprietors of the springs sometimes are.

Iodine is a valuable substance, being much used in the arts, and indispensable in medicine; and as it brings a high price, its production in the State is a matter of importance.

75. IRIDIUM. Etym. *Rainbow* (Latin).

This is one of the metals of the platinum group, and is never found except in association with the others. The metals of the "platinum group" are platinum, iridium, rhodium, osmium, and palladium. These metals are found in placers like gold, and generally if not invariably associated with that metal, and frequently with copper, magnetite, zircons, and sand. The proportions of the platinum metals vary among themselves, platinum grains being in the majority. Iridium, like the others of the group, is invariably found in the metallic state, always alloyed with platinum or osmium, as platiniridium, and iridosmine or osmiridium in flat metallic scales, tin-white, and infusible. H=67, sp. gr.=19.3—21.12, only slightly malleable. A specimen from California gave the following analysis (Dana):

Iridium	53.50
Rhodium	2.60
Ruthenium	0.50
Osmium	43.40
	100.00

Iridium was discovered and made known by Smithson Tennant in 1804. In dissolving native platinum in aqua regia a residue remained, which proved to be a new metal, iridium and osmium. Iridium being very hard is used in the arts for a number of purposes for which it is specially fitted; such as points for gold pens, called diamond points, for which purpose it must be very carefully selected. The ore is first spread on paper and the iron removed with a magnet; it is then sifted to remove fine dust, and subjected to the action of quicksilver to remove gold, then boiled with acids, washed, and dried. From what remains, pieces are picked out with forceps by hand, under a magnifying glass; only those suitable for the purpose are selected. This must be done by a person of experience. The portion rejected is then treated by fusion and the action of acids, by which platinum is separated, and it is then ready for other uses, such as the manufacture of plates for drawing steel and gold wire, knife edges for chemical balances, hypodermic needles, electric lighting, bushing for the touchholes of heavy ordnance, etc.

Iridium has been found with gold and platinum in all the stream washings or placer mines of California—also in the auriferous beach sands. As not much effort has ever been made by the miners to save it, the quantity collected in this State has not been large. During the earlier stages of gold washing, when operations were prosecuted on a more extended scale, the miners finding this troublesome stuff in their sluices, where its great weight had retained it with the gold, were at much pains to separate it from the latter, after which, being ignorant of its value, the most of it was thrown away. Afterwards, when the miners found out what it was, they began to save this metal, and small lots, finding their way to San Francisco, were sold at such prices as happened to be offered for it, there being no regular purchasers in this market. For a number of years considerable quantities of iridium continued to be sent to this city, some of it gathered in this State and some coming from Oregon. Latterly, however, the business of collecting it seems to have entirely ceased, but for what reason is not quite apparent, as placer operations are still conducted in California on a large scale. Whether the prices paid for the metal here were so little satisfactory that the miners did not care to further look after it, or whether they no longer find it in their sluices, we are not advised; the latter, however, can hardly be the case.

Of large quantities of iridium collected very little is found of the size and shape that adapts it for the special uses that render such small portion extremely valuable. For instance, hardly one per cent of any average lot will prove suitable for pointing gold pens, or for the other delicate work for which the metal is used. Selecting these particles, dealers pay for them large prices, perhaps twenty, thirty, or even fifty dollars per troy ounce; whereas, for the rejected portions, they will pay scarcely more than three or four dollars per ounce, and for a very poor quality not one quarter as much. But, even at the least price paid for this metal, it might be worth while for our miners to look after it, if the placers continue to yield it, as it can be recovered and saved, where gravel washing is going on, with very little extra labor. The cheaper and lower grade metal is used for making iridium oxide, a black pigment employed for decorating fine porcelain. It is also useful, and perhaps essential, in the production of electric lights, Edison having, it is said, sent to California for all that could here be obtained of that grade.

In melting gold in the United States Mint in San Francisco, and in the bullion refineries of the State, much iridium was collected which rose to the surface of the melted gold, and was skimmed off with the flux or dross. At the San Francisco Assaying and Refining Works, under the management of Kellogg & Hewston, large quantities were so collected. The principal localities in the State where it has been found will be given under the head of Platinum.

Iridosmine—see Iridium and Platinum.

Iron Garnet—see Garnet.

76. IRON AND IRON ORES. See also Hematite, Limonite, and Magnetite.

Of all the metals known to man, iron is the most generally useful. It has been said that the civilization of a country may be measured by the quantity of iron produced and consumed. While iron is the most useful of metals, it is at the same time the most widely distributed. Although seldom found in a metallic state in nature, it seems to permeate the earth's crust, and appears in many forms. It is one of the constituents of the granites which are considered to be almost the foundation of the earth. It is abundant as an ingredient in the volcanic rocks, and still more so in mountain masses, beds, stratified deposits, eruptive masses, etc., at many localities on the surface of the earth. It is found in mineral waters, and it circulates in solution in the veins and tissues of plants and animals.

Native iron being extremely rare, being almost wholly, as far as known, of meteoric origin, we must look to the ores of that metal for our material. These ores occur in rocks of all ages, and are abundant in California at a number of known localities. There are two distinct classes of iron ores that are sought by the smelter: those known as *spathic*, the most important of which is *siderite or carbonate of iron*, and the oxidized ores known as *magnetite, hematite, and limonite*. The latter are the most common in the State. Iron occurs in other forms, combined to a greater or less extent with other substances and metals, as *franklinite, pyrites, titaniferous iron, chrome-iron, magnetic sands*, etc., which have their uses in the arts, but which are not suitable for the production of the metal.

Long ages passed, after man appeared on the earth, before the use of iron was discovered. That metal has so strong an affinity for oxygen that it does not long remain in a metallic state, and there is nothing in the appearance of the rusty looking oxides that would indicate to the uneducated mind that a valuable metal could be extracted from them. The progress was gradual, as shown by the study of primitive man—from the use of rude stone implements to those of polished stone, then to the era of bronze and copper, followed in comparatively modern times by the use of iron. There can be no doubt that gold and copper were in common use long before iron was known. When this metal was first introduced it was, no doubt, far more precious than gold. It represented excessive labor, while gold and copper were found in a metallic state, and were easily wrought. The relative value of these metals in early times is illustrated by swords and knives of gold, the edges only being of iron, found in ancient mounds in Denmark, with older implements of the stone age, now preserved in the Museum of Copenhagen.

Manifold are the uses to which iron may be put, from the construction of the hull of a war ship to the tiniest screw in a lady's watch. It can be rolled into sheets as thin as paper, drawn into the finest wire, twisted and woven, rolled into bars that can be tied into knots without breaking. It can be forged, welded, and turned into desired shapes in lathes. It takes the polish of a mirror, and it can be melted like water and cast in quantities weighing many tons. Its salts, and compounds with other substances, have many uses in the arts; that of war being almost dependent upon iron, which has led to the naming many of its salts after Mars, the war god of the ancients. In short, this metal has become almost indispensable to mankind.

There are three kinds of iron in common use: crude cast or pig iron, malleable or bar iron, and steel. The different states of the iron depend principally on the quantity of carbon they contain. Cast iron has the most, and bar iron the least. All iron was formerly smelted by the heat generated by the combustion of wood charcoal. In sixteen hundred and eleven it was discovered that mineral or pit coal could be substituted for charcoal, which revolutionized the iron manufacture. It was not, however, successfully used until one hundred and twenty-four years later. In fifteen hundred and eighty-four the attention of the British Government was called to the threatened destruction of the forests by the use of the wood for making charcoal for iron furnaces. An Act of Parliament was passed restricting the use of wood for that purpose.

In countries where forest trees are abundant, charcoal is still extensively used for the production of crude iron. In California, for the time being, this fuel must be used, unless our extensive deposits of petroleum can be utilized for that purpose. In early times rude and temporary furnaces were used for smelting, but in modern days they have been improved until they have become models of human ingenuity and skill. They now represent large capital. They are costly and complex, and, at the same time, nearly perfect in all their parts, the result of consecutive years of experience and study.

As molten iron comes from the blast furnace, it is formed into rude ingots known as "*pigs*," or "*pig iron*." In this state it is very hard and impure, and can be put only to limited use. To render it malleable is to purify it of certain objectionable substances, such as sulphur, phosphorus, and, more especially, carbon. This is effected by a process called "puddling," by which nearly all the carbon is oxidized. For this purpose a peculiar furnace is used, called, from the operation, a "puddling furnace," in which the crude iron is subjected to the action of heat, and a blast of atmospheric air so managed that the impurities are eliminated, and by a system of stirring, which is very laborious, the soft iron is aggregated into "puddle balls," which are, while in a semi-molten state, hammered, squeezed, or rolled by heavy machinery, until the purified metal becomes homogeneous, and is ready to be drawn into bars or rolled into sheets, as may be required. The same in effect is accomplished in a large way by the Bessemer and other modern processes.

In view of the importance to California of a supply of cheap iron of home production, and as it is desirable that many idle hands should be employed, and that money sent abroad for what could well be produced in the State, should be retained in the land to circulate among our citizens and impart new life to our waning prosperity, it is interesting to know that at least one of the iron deposits of the State is being developed, and the question solved as to whether labor and capital in California can and will coöperate to their mutual advantage, and thus institute important iron interests leading to other industries and manufactures, without which the State must recede rather than advance in prosperity and importance.

The deposit alluded to is in Placer County, near Clipper Gap. The property is in the hands of some of California's most enterprising citizens, and what is very important in a work of such magnitude, is backed by ample capital. The furnace and charcoal ovens were nearly complete when visited by the State Mineralogist in October, 1883. The furnace is constructed on the most modern and approved plans. No expense has been spared to make it as complete and perfect as possible. It is due to the State Geological Survey, conducted by Professor Whitney, to state here that the information which led to this important result is given in the volume on Geology, folio 284, in the following words:

> The ore crops out on a hillside and forms a mass more than thirty feet thick, of which the longitudinal extent is not known, although it is evidently considerable. It is hematite, perhaps mixed with some limonite, and has not yet been analyzed. It appears, however, to be of excellent quality, and is remarkably pure and free from intermixture with rock. With the present prices of fuel and labor, it is not easy to say how soon California will be able to manufacture her own iron; but this locality is, perhaps, more favorably situated than any yet discovered in the State for trying the experiment.

This statement, published eighteen years ago, attracted the attention of a gentleman identified with the iron interests, and led to the enterprise above mentioned.

Samples of ores, limestones, fire clays, and other products have been sent to the State Museum.

IRON ORES AND IRON INDUSTRIES OF CALIFORNIA.

Few countries consume so much iron in proportion to their population as California, notwithstanding this metal has here always commanded extra high prices. This comparatively large consumption grows out of our considerable requirements for mining purposes, and the extent to which we employ this material in building houses, fences, bridges, etc., the high prices we have had to pay for it being due to the fact that our supplies have been imported from distant sources of production, subjecting them to heavy freights and other charges, and compelling dealers to keep large and varied stocks constantly on hand. The destructive fires that so frequently occurred in the early history of the State, led to a free use of iron in the erection of warehouses, stores, and other business structures in cities and larger towns. Additional demands meantime had sprung up for the outfitting of quartz mills, hydraulic plant, etc., the growth of such demands keeping pace with the expansion of these several branches of mining. The substitution of iron pipes for wooden flumes for conveying water across rivers, ravines, and other depressions, has also called for a good deal of iron. Then came the era of railroad construction, adding immensely to other causes of iron absorption, all of which have kept on year by year, undergoing steady enlargement. Besides supplying the Pacific States and Territories, our shops and foundries have turned out great quantities of mining machinery and castings for northwestern Mexico, South and Central America, and British Columbia, with some products in this line for China, Japan, and the islands of the Pacific, the Hawaiian sugar planters having here obtained all their mills, pans, etc. But with requirements so great and the raw material of superior quality scattered abundantly all over the State, not until recently were any well directed and effectual efforts made to manufacture iron in California, the cost of production and fear of foreign competition having deterred even the most enterprising from undertaking it. Although companies had before been formed for producing this metal here, and even taken some preliminary steps in the business, not until 1880 was any purpose of this kind prosecuted to a determinate and successful issue.

QUANTITY AND COST OF IRON USED.

The annual consumption of pig iron on this coast during the past ten years has averaged about fourteen thousand tons, nearly as much more iron in the shape of bars, sheets, and in other forms, having meantime been consumed. The whole of this, with the exception of some little made in Oregon, has, up till the past year, been imported from the eastern States and Europe, mostly from the latter. As the price of pig iron in San Francisco has averaged thirty dollars per ton, and of other kinds at least three times as much, our annual expenditures on account of this item have amounted to $1,350,000—$13,500,000 for the above period, and $35,000,000 or $40,000,000 since the State was founded. That such a drain upon our means should have been suffered to go on so long without any effectual steps being taken to check it, does not argue well for either the thrift or the enterprise of our people; more especially as we possess the raw material in such profusion, as well as the skill and capital requisite for transforming it into useful shapes. What has tended to somewhat relieve the stringency of the iron question here has been the manner in which the extensive rolling mills, erected in San Francisco some fifteen years ago, have since been able to work up the large quantities of old iron that before were either thrown aside as useless, or gathered up and shipped out of the country. Except as affected by the product of these rolling mills, our iron market has, until lately, been without any competitive check. Besides filling orders for iron in cases of emergency, and which could otherwise have been filled only after a long delay, these mills have, in a general way, rendered valuable service to all our other industries. Nevertheless, many of our vital interests have suffered materially through long neglect to produce at home this article of prime necessity.

IRON DEPOSITS OF CALIFORNIA.

As before remarked, beds and veins of iron ores are widely distributed over California, our wealth in this mineral being surpassed by that of few other countries in the world. We have iron fields in the northern, central, and southern counties, and even far out on the deserts that occupy the northeastern and southeastern angles of the State. Iron ore occurs in reefs high up in the Sierra Nevada, and even in notable quantity among the sands along the ocean beach. We do not claim to have mountains of this metal, but in our inexhaustible deposits we have what amounts practically to the same thing. These most useful of all ores are found here, not only at many points and in the greatest profusion, but they are varied in kind and excellent in quality.

IRON ORES IN SHASTA COUNTY.

Throughout the whole tier of our northern counties iron ore, at least on the surface, is met with. The deposits near Crescent City, though not much explored, are apparently extensive, and being close to an eligible shipping point will, no doubt, prove valuable. In Shasta County the ores of this metal are especially abundant. At Iron Mountain, situate a short distance north from the town of Shasta and three miles west of the Sacramento River, exists an extensive bed of iron ore. The deposit crops out on the mountain side, exposing thousands of tons of ore in place, detached masses of great size being also scattered over the surface of the ground adjacent. As there is limestone and timber not far off, this mine could be profitably worked by bringing the ore, fuel, and flux together on the railroad, when it comes to be extended north from Redding, the present terminus, as it soon will be. As this property belongs to men of large means, something will probably be done with it when the railroad is advanced to a point opposite the mine, and from which it will be but three miles distant.

IN SIERRA COUNTY.

At a point twelve miles northeast of Downieville, and at an elevation of 6,200 feet above sea level, occur very extensive deposits of magnetic iron ore, much of which carries from forty to fifty per cent of metal. Touching the character and extent of these deposits, Baron Von Richthofen, in a report upon the same to the owners, remarks as follows: "Your mines consist altogether of magnetic iron ores, the same from which the celebrated Swedish and Russian iron is manufactured. A total amount of ore which may be extracted from the different deposits, by quarrying, I estimate at about 1,400,000 tons—average yield, from forty-five to fifty per cent. Even the removal of the ore next the surface will be the work of a generation." The ore here is represented to be so highly magnetic that it not only attracts the needle, but possesses polarity. This ore is found in three conditions—massive, with a bright steel luster, intermixed with carbonate of lime, and interspersed, in the form of crystals, through chlorite and talcose slate. Thousands of tons of it could be readily mined, and there is plenty of wood and water in the vicinity, but the deposits are so remote, and at present so difficult of access, that they possess little or no commercial value. In working them, nearly eighty miles of wagon transportation, over mountain roads, would have to be made, at a cost of $20, or more, per ton. With a railroad leading to Oroville, or through the mountains to some point on the Central Pacific, the ores here could no doubt be reduced with profit.

BLACK SANDS.

Mixed with the sand on the ocean shore, and extending for long distances both to the north and south of San Francisco, are immense quantities of magnetic iron ore, and which occurring in the form of small particles, constitute a considerable portion of these beach sands. A sample of this sand, taken from a drift near the end of the California Street Railroad, San Francisco, partly concentrated by the wind, contained 5.63 per cent of magnetite. Deposits of a similar character are abundant along the entire coast line of the State. It would, of course, be practicable to separate this ore from the silicious particles with which it is intermixed, by washing, or by the use of magnets, as practiced in some other countries; a process with which we, but for our more available deposits elsewhere, might be tempted to experiment. This magnetic sand makes iron of such superior quality, that it has, in some places, long been employed for that purpose. At Moisic, in Canada, and also in northern New York, this class of ore is extensively smelted after being separated from its associated earthy impurities through the employment of magnets, which perform the work cheaply and quickly. In some cases massive iron ore is pulverized, in order to be cleaned in this manner.

IRON MAKING ON THE PACIFIC COAST.

The California Iron Company was organized in the month of January, 1880, and inaugurated active operations immediately thereafter at Hotaling, Placer County, extensive tracts of iron-producing and timber-bearing lands, at and in the vicinity, having previously been secured. During the first year dams, roads, and bridges, some of them very costly structures, were built; houses, shops, and other out-buildings were put up, and a very complete blast furnace erected. Expensive machinery, including a powerful steam engine, was gotten on the ground and put in place, the propulsive power here employed being steam. Although operations in the field were consigned to seemingly competent hands, the company did not wholly escape the blunders and mishaps which at the outset are so apt to attend ventures of this kind. Some portions of the works, owing perhaps to a lack of proper supervision or planning, proved so defective as to necessitate extensive repairs, and, in some cases, entire rebuilding, within a very short time after they were finished.

But, despite these disasters and troubles, the company succeeded in advancing their works with a good deal of rapidity, getting their furnace, which has a smelting capacity of 25 tons per day, ready for operations in April, 1881. The product of this furnace for that year amounted to 4,260 tons of pig iron—being at the rate of about 500 tons per month for the time it was in blast. The monthly product made by this company during the first half of 1882, and up to the time of their retirement from business, having been somewhat larger than during the preceding year.

The metal made by them has met with ready sale, at extreme prices, having been regarded with great favor by all classes of iron workers and dealers, who prefer it to the best imported brands, it being, in fact, actually worth from $8 to $10 per ton more than the latter. The California Iron Company has been succeeded by

The California Iron and Steel Company.—The new company, though composed mainly of the members of the old, have greatly enlarged the plans and purposes of their predecessors, it being their intention to enter extensively into the manufacture of bar and plate iron, steel rails, etc., as well as carry on the business of making pig metal. To this end they have not only purchased the entire estate of the old company, consisting of their ore beds, furnace, charcoal kilns, wood lands, roads, ditches, etc., but have projected large establishments, some of which are already completed, for carrying out the above objects.

While constructing these new works the company's smelter was kept in full blast up to the time of its partial destruction by fire, in the month of September, 1882, causing a temporary interruption of this branch of their business. With these multiplied and enlarged aims, it will become necessary for the company to increase the capacity of their smelting works, a measure that will meet with early consummation, and which, when carried out, must have the effect to largely curtail the importation of pig metal thereafter. With the product of the Washington and Oregon furnaces it is even probable that the importation of this staple will, in the course of a few years, cease altogether, with the exception of such small quantities of Scotch pig as are required for admixture with our home made iron. Meantime, extensive rolling mills will be put up at some eligible site, probably in the city, or at some point on the Bay of San Francisco, the nail factory that forms a part of this project, being already finished and fully equipped for active service. This establishment, which consists of seven large buildings, having a floor-room of nearly 53,000 square feet, is located in West Oakland, on the line of the Central Pacific Railroad. Besides nails of various kinds, files, tacks, brads, hardware, and many other articles composed of iron will be manufactured here. This company is made up of successful, practical men, each member being peculiarly fitted, by experience and natural qualifications, for looking after some particular branch of the business they have undertaken. They are all men of large wealth, and at the same time active workers—men who earn and execute as well as think and plan. The cash investment made by the members of the California Iron and Steel Company on account of the Clipper Gap estate alone, approximates half a million dollars, their disbursements elsewhere having been very considerable. As their sagacity in divining the future of the State has rarely ever been at fault, these heavy ventures may be construed into omens favorable to our industrial future.

Since the preparation of my second annual report, this industry has undergone some expansion, and, in view of the condition of the business elsewhere, may here be considered to be fairly prosperous.

The California Iron and Steel Company having rebuilt their furnace, and again commenced smelting operations in May, 1883, have since turned out 15,000 tons of pig iron. This iron being of good quality, has met with ready sale on the San Francisco market at current prices, being now extensively used by our foundries, nail works, and other local factories. During the past year this company have increased the capacity of their plant, acquired additional wood lands, and otherwise improved and enlarged their property. The survey of a railroad route between their smelter and Clipper Gap, on the Central Pacific Railroad, indicates a purpose on the part of the company to connect these two points by rail. This enterprise being in the hands of men of large means and progressive ideas, will be kept well up with the times as regards the adoption of the best methods and appliances extant in this line of business. This company employs about three hundred hands—furnacemen, wood choppers, coal burners, teamsters, etc , included.

The Puget Sound and the Oswego Iron Works—The one located at Port Townsend, Washington Territory, and the other near Portland, Oregon, are the only works on the Pacific Coast that make any iron outside of California, except a little produced in Utah. These northern works have lately been running to their full capacity, with the prospect of being kept steadily employed in the future; the business activity incident to the completion of the Northern Pacific Railroad having created a lively demand for iron all through that region. Very little iron from these works was ever shipped to California, and hereafter it is not likely that any at all will be sent to this market.

The Judson Manufacturing Company—Whose establishment is located at West Oakland, have, in pursuance of their original intention, gone on introducing one new industry after another, until half a dozen or more important branches of business are now being carried on there with marked success: Thus, we find grouped together here an extensive foundry, forges, and rolling mills, a file, a nail, a tack, and general hardware factory; a department for making mowing machines and other agricultural implements; spacious wood, paint, and blacksmith shops, the whole supplemented with pattern, drawing, and packing rooms, and the other usual adjuncts of such large and varied plant. The establishment has been superbly equipped, and the enterprise being under an able business and financial administration, promises to become a great success. The tools made here cover a wide range and are of pronounced excellence; and such is the company's confidence in their ability to do good work in every branch of business undertaken by them, that they have furnished their works with machinery for making everything they will hereafter require in the prosecution of their multifarious industries. The iron used by this company consists of the Clipper Gap pig almost exclusively, converting it into blooms in their own forges when bar and other forms of wrought iron are required. This company have in their service over four hundred employés, a portion of them boys, women, and girls; the sum paid out monthly for wages amounting to about $20,000.

The Pacific Iron and Nail Company—Have recently put up in the city of Oakland a rolling mill, a nail factory, and a machine shop, whereat a working force of two hundred and twenty-five hands are steadily employed, at an expense for wages of $12,500 per month. Eight steam engines, with five boilers, supply here the requisite motive power. Of the seventy-one nail machines run, sixty-three are self-feeding, the rest being fed by hand. The preparation of the iron and the manufacture of nails of almost every variety constitute here the principal business carried on, the value of the products turned out being at the rate of $750,000 per year. The company is financially strong, and is doing a prosperous business.

Various other works—For the manufacture of iron, or for the conversion of iron into steel, have been projected in this State, some of these being already in course of construction, one or two nearly completed. A company is putting up an establishment for making steel at the town of Martinez, in Contra Costa County, and have it well advanced, the building being finished and much of the machinery in position. The site of this company's works has been well chosen, both as regards railroad and water transportation. To facilitate shipments by vessels, they will build a wharf at that place. This company will manufacture all kinds of steel by a new process, so cheap and effective, as is claimed, that it will bring to them great advantages. Works are also being put up at the city of Los Angeles for making steel in connection with the manufacture of boilers, bolts, etc., these works being now nearly ready for operations.

The Pacific Rolling Mills Company, of San Francisco, have recently added to their establishment open hearth steel works, with a yearly capacity of 10,000 tons. To the single furnace now in use others will be added, should trade requirements justify. The method employed here is that known as the Siemens-Martin process, by which a very superior steel is produced. In operating this process the company have already achieved a notable success. These rolling mills, the pioneer in this line, having been erected in 1866, remain the most extensive on the coast, the working force here employed, though much reduced just now, amounting in ordinary times to nearly 800 hands. The products of these works include about everything made at similar establishments elsewhere, the principal articles manufactured consisting of steel and T rails, bar and band iron, car and locomotive axles and frames; steamboat shafts, cranks, pistons, etc.; ships' knees, chains, and anchor stocks, with a long list of minor articles, such as spikes, nails, bolts, screws, rivets, etc. Of the 26,000 tons of rails and nail plates turned out in California in 1882, much the greater portion came from these works.

The Union Iron Works Company, another of the pioneer institutions of San Francisco, have during the present year erected on an eligible site at the Potrero new buildings, to which their large business will in a short time be transferred. To each of the capacious buildings here put up will be assigned one or more of the various branches of business carried on by the company; one will serve for the boiler department and the smitheries, another for the iron and brass foundries, a third for the machine shops, etc. These buildings, which cover an average ground area of 50,000 square feet each, are divided into compartments separated from each other by rows of cast iron columns thirty-two feet high. These works have been furnished throughout with the most perfect, powerful, and labor economizing tools, mechanisms, and appliances yet invented. When completed, the establishment will present a model in its way, both as regards equipments, convenience, and sanitary arrangements. A hydraulic lift dock and a marine railway, both nearly finished, form a part of the company's new works; it being their intention to make the building of iron vessels a specialty. This dock has capacity to take up vessels 500 feet long. A spacious wharf, to which ships of the deepest draft can come up, two lines of rails, the one extending from the wharf to the shops and the other connecting the latter with the outside railroad system, constitute other features of the improvements here made.

While the business of producing, casting, rolling, forging, and otherwise manipulating iron has with us, during the past year, shared to some extent the depression common the world over, it has, nevertheless, been pretty active, and in some of its departments tolerably remunerative. The loss sustained by this industry through the partial cessation of hydraulic mining and railroad building has, in some measure, been made up by the preference everywhere given for our mining machinery, for which there have been heavy orders of late from South America, Africa, and other foreign countries. Our importations last year consisted of 23,142 tons of soft, 1,838 tons of white, and 17,780 tons of scrap iron. Importations of white and soft have, during the past five years, been as follows:

Years.	Tons.	Years.	Tons.
1879	9,359	1882	19,993
1880	13,202	1883	24,980
1881	8,600		

A visit was recently made to the Iron Monarch iron mine, near Campo Seco, Calaveras County, No. 3763.

The altitude by aneroid was found to be 620 feet—the locality shows large cropping of limonite. The formation in which it lies seems to be a highly ferruginous sandstone conglomerate, containing bowlders of quartz imbedded. For 2,400 feet northerly and southerly there are here indications of iron ore, with an occasional outcrop. At the north end of the claim there is a hill overlaid with white water-worn quartz bowlders. The whole country seems to have been covered with a drift of quartz bowlders, similar to those in the hydraulic mines at Dutch Flat, Placer County, which lie nearly north, and about sixty-six miles distant. There is no reasonable doubt as to the common origin of these beds or deposits. The country has been denuded irregularly, and the drift left on the summits of hills and table mountains so formed. The Clipper Gap iron mines are similarly situated. Near Messenger's House, Section 6, Township 4 north, Range 11 east, there is a cropping of good limestone suitable for building purposes, flux for iron ore, and lime burning, and also a porphyritic stone similar to that near Clipper Gap, but softer, and a volcanic ash or tufa (5601), which seems to be suitable for building, and of which several houses have been constructed. Of this stone there is a fine specimen in the

State Museum, No. 5601. The following is an analysis by W. D. Johnston:

Silica	72.00
Alumina	26.20
Sesquioxide iron	.60
Lime	.51
	99.31

Of the iron ores five samples were selected to represent gradation from best quality to the poorest; of these samples assays were made by Falkenau & Reese, as follows:

No.	Ferric Oxide.	Per Cent of Iron.
1	80.	56.
2	69.	48.3
3	64.	44.8
4	59.	41.3
5	7.5	5.15

CALIFORNIA IRON ORES IN THE STATE MUSEUM.

(1861.) Hematite, Ochrous—Clipper Gap iron mine, Section 24, Township 13 north, Range 8 east, Mount Diablo meridian, Placer County.

(3585.) Magnetite—Near the New England Mills, Placer County.

(1333.) Magnetite, in dodecahedral crystals—Six miles from Auburn, Placer County.

(3361.) Hematite and Magnetite—Near Crescent Mills, Plumas County.

(3756.) Magnetite—Mohawk Valley, Sierra County.

(1712.) Iron Ore, Oxide—Average from tunnel, Iron Mountain mine, seven miles from Shasta, Shasta County.

(1873.) Magnetite—Iron Mountain, Shasta County.

(20.) Magnetite—McCloud River, Shasta County.

(3422.) Jaspery Iron Ore—Northwest corner of Sonoma County, near Point Arena.

(3759.) Magnetite—San Bernardino County; six miles from water.

(2886.) Magnetite—Eight or nine miles north of Mesquite Station, San Diego County.

(1552.) Limonite or Hematite—Harrington iron mine, San Luis Obispo County, California, four miles southwest of the city of San Luis Obispo, on subdivision of the Rancho Canada de Los Osos, Township 31 south, Ranges 11 and 12 east, Mount Diablo meridian. The ledge has a northwesterly direction, with a dip to the west. Supply of ore seemingly inexhaustible.

(3762.) Iron Ore, Limonite—San Luis Obispo County.

(3774.) Iron Ore, Limonite—Twenty-five miles east of Visalia, Tulare County.

(1519.) Black Sand—Concentration from hydraulic washing, Hopland, Mendocino County.

(3639.) Iron Ore, Magnetite—Solid Iron mine, Indian District, Mono County.

(3768.) Iron Ore, Magnetite—Near Benton, Mono County.

(3757.) Magnetite—Near St. Helena, Napa County.

(3758.) Metallic Iron, reduced from magnetite found near St. Helena, Napa County.

(3773.) Iron Ore, Hematite—Holden Ledge, Township 15 north, Range 7 east, Mount Diablo meridian, Nevada County.

(3767.) Iron Ore, Magnetite—Grass Valley, Nevada County.

(2397.) Limonite Concretions—Forest Hill, Placer County.

(1937.) Hematite—From Red Hill, Section 15, Township 13 north, Range 8 east, Mount Diablo meridian, Placer County.

(1938.) Magnetite—Section 15, Township 13 north, Range 8 east, Mount Diablo meridian, Placer County.

(2848.) Pig of Cast Iron—From the first cast made by the California Iron Company, Sunday, April 23, 1881. Works at Clipper Gap, Placer County.

(4019.) Iron Buttons—Obtained in crucibles, from the Campo Seco iron ore, Calaveras County.

(3760.) Iron Ore, Limonite, and Hematite—San Andreas, Calaveras County.

(4058.) Iron Ore—Said to occur in large quantities one mile northeast of Sperry's hotel, Murphys, Calaveras County. It lies between limestone and slate. Plenty of wood and water.

(1896.) Hematite—Occurs in the rock formation, Kelsey Tunnel, fourteen miles southeast of Crescent City, Del Norte County.

(965.) Magnetite—El Dorado County, California, two miles northwest of Shingle Springs.

(3712.) Siderite, Carbonate of Iron—Tejunga Cañon, Los Angeles County.

(4148.) Iron Ore, Limonite—Near Latrobe, El Dorado County. Vein twenty-two feet wide. Plenty of wood and water. Metallic iron, 55.41 per cent.

(1996.) Magnetite—Coulterville, Mariposa County.

(3717.) Limonite, after Pyrite, perfect crystals—Chowchilla Valley, Mariposa County.

(3005.) Magnetite—Base of Mount Hoffman, south side of the dividing ridge between Mariposa and Tuolumne Counties.

(3006.) Magnetite in gangue—Base of Mount Hoffman.

(1673.) Magnetic Sand with Pyrites—Hydraulic washings, two miles northeast of Jackson, Amador County.

(87.) Hematite—Ione Valley, Amador County.

(3750.) Nodule of Hematite—Near Volcano, Amador County.

(2833.) Earthy Hematite—Monitor, Alpine County.

(2336.) Hematite—Alameda County.

(2788.) Iron Ore, Magnetite—Oroville, Butte County.

(2285.) Micaceous Iron, Hematite—Feather River, near Oroville, Butte County.

(3763.) Iron Ore, Limonite—Iron Monarch mine, Township 4 north, Range 10 east, Mount Diablo meridian, opposite Section 3, in unsurveyed land, two miles in a southerly direction from Campo Seco, Calaveras County.

(3766.) Iron Ore, Hematite—Big Tree iron mine, Calaveras County.

(2455.) Iron Ore, Limonite—Between Jenny Lind and Campo Seco, Calaveras County.

(2745.) Impure Red Ochre—McPherson's claim, Sheep Ranch district, Calaveras County.

(4010.) Yellow Ochre, Limonite—Found in considerable quantities adjoining an iron mine, Campo Seco township, near Campo Seco, Calaveras County. Valuable as a pigment.

(4011.) Burnt Ochre (same as No. 4010)—Near Campo Seco, Calaveras County.

Isinglass—see Mica.

77. JAMESONITE. Named from *Jameson*, Scotch geologist. Sulphide of Antimony, Lead, Iron, Copper, and Zinc.

This mineral is represented in the State Museum by a single specimen, No. 2262, from Mokelumne Hill, Calaveras County.

Jasper—see Quartz.

78. JEFFERISITE. Named from *Jefferis*, mineralogist, of Pennsylvania.

A mineral resembling mica, which is a hydrous silicate of numerous bases, principally alumina, iron, and magnesia. Specimens in the State Museum are (2126), from Susanville, Lassen County, and (4911), from Tulare County.

Kaolin—Kaolinite—see Clay.

79. LABRADORITE. Etym. *Labrador*. Feldspar.

This mineral has been observed in small quantities in street pavement blocks in San Francisco; the exact locality is not known.

80. LEAD AND LEAD ORES. See also Galena, Anglesite, and Cerusite.

Metallic lead has a bluish gray color. It is usually tarnished, in which case it has no luster, but when freshly cut shows a surface highly metallic and brilliant. It is a soft metal, very malleable, easily fusible, and volatile at a white heat. It is scarcely acted upon by hydrochloric acid or dilute sulphuric acid; but moderately dilute nitric acid dissolves it, more readily if heat is applied.

The presence of lead in any substance containing it may with certainty and ease be determined by heating the sample on a piece of well-burned willow charcoal, in one portion of which—nearest the flame—a small cavity or depression has been made, in which the assay may be placed, a little carbonate of soda added, and the flame of an oil lamp or large candle turned upon it by means of the mouth blowpipe. The direction of the flame at first should be downwards until the assay begins to melt, after which it should be blown softly and nearly horizontally across the charcoal. If lead is present in the assay a coating will form on the charcoal which is lemon yellow when hot and sulphur yellow when cold. Other volatile substances which may be present may also form coatings, but they will be characteristic, and at distances more remote from the assay, nor will they be the same color. Zinc, like lead, gives a yellow coating, which to the inexperienced might lead to mistakes, but if the charcoal is allowed to cool, the zinc coating will become white, by which reaction it may be distinguished.

The following are the reagents used in the determination of lead in the wet way, and the reactions which occur:

Hydrosulphuric acid or sulphide of ammonium added to solutions of lead salts, gives black precipitates of sulphide of lead, which are not soluble in cold dilute acids, alkalies, alkaline sulphides, or cyanide of potassium, but the precipitate may be decomposed by boiling nitric acid. The acid must be dilute or a part of the lead will be changed to the sulphate and remain insoluble.

Soda, potassa, and ammonia, throw down basic salts of lead in the form of white precipitates, which are insoluble in ammonia. The exception is solution of acetate of lead, from which pure ammonia (free from carbonate) does not immediately produce a precipitate, a soluble triacetate of lead being formed.

Carbonate of soda produces a white precipitate of basic carbonate of lead, when added in solution to the solution of any lead salt. This precipitate is not soluble in excess of the precipitant, nor in cyanide of potassium.

Hydrochloric acid or the soluble chlorides produce in solutions of the lead salts, if concentrated, a heavy precipitate of chloride of lead, which is soluble in a large quantity of warm water.

Sulphuric acid and sulphates throw down from lead solutions a heavy precipitate of sulphate of lead, which is nearly insoluble in water and dilute acids, but dissolves readily in solution of citrate of ammonia.

Chromate of potassa when added to solution containing lead throws down a beautiful yellow precipitate of chromate of lead, which dissolves in potassa, but which is nearly insoluble in nitric acid.

It should be understood that the above reagents are in solution, and are to be added in every case to solutions of substances containing lead.

Lead occurs in nature in a variety of forms, but most of the metal furnished to commerce is from galena or sulphuret of lead. Native lead is reported as occurring in globules at Alston Moor and at the mines near Cartagena, Spain, but never in sufficient quantity to work, or even to furnish specimens for the cabinet of the mineralogist.

Galena, the most abundant ore of lead, has a metallic luster. Its color and streak are pure lead gray. When broken it is still cubic in form, even when reduced to the finest powder. It always contains silver, and sometimes selenium, zinc, cadmium, manganese, gold, antimony, copper, and iron. Even platinum is said to be found in galena in France.

It is a mistake to suppose that any external appearance indicates the quantity of silver in a sample of galena.

There is a variety of galena which is called supersulphuretted lead. The excess of sulphur results from the decomposition of a portion of the galena, setting the sulphur free.

There are several minerals which resemble galena, and may easily be mistaken for it. The most common is micaceous iron, a variety of hematite. The resemblance of this mineral to galena is sometimes so striking as to deceive the inexperienced. It may, however, be distinguished by the following tests: When heated on charcoal it gives off no odor of sulphur, nor can it be fused before the blowpipe. No metallic beads are formed when carbonate of soda is added. After strong heating it becomes red, and on cooling is found to be attractable by the magnet.

Galena, anglesite, and cerusite have been noticed under their special headings.

ASSAY.

The assay of lead in the dry way is never absolutely correct, for several reasons: First, from the volatile nature of all lead compounds, making the result too small; second, from the tendency of other metals to alloy with the lead, as gold, silver, copper, antimony, etc., giving results too great; third, when sulphur is present some of the lead sulphide is liable to form a slag or "matte" without being decomposed, and thus to escape determination. Notwithstanding these sources of error, such assays approximate to the working of the ores in a large way, and when carefully made and verified by proofs, are generally accepted as correct.

The wet assay, although attended with some difficulties, is by far the most accurate and reliable.

Before lead ores are prepared for assay in the dry way, regard must be had to their chemical character. It is best to divide them into classes, each of which must be treated by a different process.

Class 1. Ores containing either sulphur or selenium, or both.

Example: Galena, clausthalite, lead matte or regulus, furnace products, etc.

Class 2. Ores containing oxide of lead combined with various mineral acids, sulphuric acid, chromic acid, phosphoric acid, arsenious acid, carbonic acid, etc.

Example: Anglesite, cerusite, pyromorphite, etc.

Class 3. Metallic lead alloyed with other metals.

It is easy to distinguish to which class a specimen of lead mineral belongs. It has already been shown how to test a mineral for lead. After doing so observe if it has a metallic luster and a certain degree of malleability, showing a bright metallic streak when freshly cut. It will not be difficult to determine if it is an alloy by these tests. If so, it evidently belongs to Class 3. If not, fuse a small piece with carbonate of soda on charcoal; when cold remove the slaggy mass and place it on a clean silver coin and add a few drops of water. If the silver is blackened so that the stain cannot be washed off with water, the mineral contains sulphur or selenium in some form. Before testing for sulphur with carbonate of soda and silver, the purity of the soda must be proved by wetting a small portion of it after fusion, and laying it on the bright silver. If pure, no blackening will appear. If the reverse should be the case, the reagent is worthless and should not be used; such soda can be purified, but the process cannot be explained here. As sulphate of lead belonging to Class 2 gives this reaction. A second piece of the ore must be placed in a clean glass tube, four or five inches long, open at both ends, and heated while holding the tube in an inclined position. If sulphur is present as a sulphide, or if selenium is present, the smell can easily be recognized if the upper end of the tube is held near the nose. If sulphur, the smell of burning sulphur will be observed. If selenium, that of rotten horseradish will be distinguished. If no sulphur is detected (Class 1) the substance belongs to Class 2.

Having decided to which class the substance belongs, it may be pulverized, passed through a sixty mesh sieve and thoroughly mixed.

If in a metallic state (Class 3) a portion may be cut off with a cold-chisel, rolled out thin and cut into shreds with a pair of scissors, or may be drilled and the borings taken for assay.

ASSAYING AVERAGE SAMPLES.

It is often required to sample a number of lead bars, and to make an assay representing the average of them all. The best method of proceeding is to drill a hole into each bar deep enough to obtain borings sufficient for duplicate assays. To insure a correct result it is best to take a portion from several parts of each bar; the samples should be numbered or marked to correspond with a similar mark or number on the bar. The bars are then weighed. If of uniform weight, equal portions by weight of the borings are thoroughly mixed and a portion of the mixture assayed, according to the directions to follow. If of unequal weights, the same weight in grams of each, corresponding to the weight of the bar in pounds, is mixed for assay. If extreme accuracy is desired, the result may be verified by making single assays of each sample, and taking the mean of the result.

ASSAYING FIRST-CLASS ORES.

There are a number of methods of assaying ores of the first class, each one having its own advocates:

1. *Fusion with carbonate of potash.*—In case the ore contains but little sulphurets other than those of lead, but more or less of earthy matter.

2. *Fusion with black flux.*—(Black flux is made by mixing two parts of argol and one part nitre in an iron vessel, setting the mixture on fire and allowing it to burn until all action ceases.)

3. *Fusion with or without fluxes in wrought iron crucibles.*

4. *Fusion with carbonate of soda and nitre.*

5. Fusion in clay crucibles with fluxes and metallic iron.

For all practical purposes the last mentioned is the best, and the modification proposed by Mitchell is simple and accurate.

For the assay, ordinary sand crucibles, triangular at the top, are used (called Hessian crucibles). The most convenient size is four and one half inches high. It is recommended to smear them inside with plumbago, but I have never found this precaution necessary. Twenty grams of the ore are weighed out and placed in the crucible; 5 grams of argol, 20 of carbonate of soda, 5 of carbonate of potash, and 10 of borax, are added, and the whole thoroughly mixed with a spoon or spatula. Three large nails are then placed, head downward, one in each corner. They must be pushed down to the bottom of the crucible, and the crucible tapped on the mixing table when the mixed contents form a level surface around the nails. The surface of the assay must then be covered with common salt (twenty grams will be about the amount required), and the crucible again tapped on the table, to settle all down evenly and compactly; ten grams of borax in lumps is put loosely on top, and the crucible is ready for the fire; a second crucible must be prepared exactly like the first for the duplicate assay. *No single assay should be trusted.*

PRECAUTIONS IN FUSING.

I have given the quantities of the fluxes by weight, but after practice the assayer will be able to mix the assays by using a spoon about the size of an ordinary tablespoon and judging of the quantities by his eye. A little more or less of the fluxes does not materially matter. He will soon be able to judge of the quantity required and from the appearance of his crucible in the fire know what to add to make it fuse freely. Any addition that may be required may be made by wrapping the dry flux in a piece of paper and dropping it into the hot crucible with the cupel tongs. There are certain precautions to be observed in fusing the assay. Too hot a fire is apt to volatilize a portion of the lead, causing loss, while too slow a fire does not effect the perfect fusion of the assay, and the globules which form cannot gravitate to the bottom, there to form a single prill or button. It is best to commence with a good fire which has burnt rather low, but in a hot furnace. The crucibles are placed on the hot coals and fresh fuel built up around them by putting in charcoal or coke, as the case may be, in lumps singly with the cupel tongs. The dampers and doors of the furnace are then arranged so as to produce the best draft. When the fresh fuel is igniting the fusion progresses slowly. The furnace soon becomes very hot, which is the exact condition required for the finishing of the fusion. The crucibles which are at first covered must toward the end be uncovered and the covers need not again be replaced. When the assays are in the most perfect state of fusion the crucibles may be removed one at a time with suitable crucible tongs. As soon as removed from the furnace a rotary motion should be given to them (soon learned by practice). This motion causes the fluid slag to sweep round the inside of the crucible, washing down to the center any stray globules. The nails are then removed by taking them out one by one with the cupel tongs, washing off any adhering lead by rinsing them in the liquid slag. When the nails are removed the crucible is tapped against the brick floor or against any hard non-inflammable substance, and set in some convenient and safe place to cool.

When cold the crucible must be broken on an anvil and the button of lead hammered into a cube and weighed. Both buttons should weigh alike or nearly so.

CALCULATING PERCENTAGE.

The calculation of percentage is simple: Suppose the twenty grams of ore contained 9.462 grams of lead; it is clear that 100 grams would contain five times as much. The number of parts in one hundred being the percentage, the result would be as follows: $9.462 \times 5 = 47.31$ per cent.

ANTIMONIAL GALENA.

Galena often contains antimony in the form of sulphuret, in which case the method described above would not give correct results. The presence of antimony may be proved by reducing a bead with carbonate of soda on charcoal. If the ore contains antimony white fumes will be given off, and a white coating on the charcoal will be seen more distant from the assay than the yellow coating of lead; or the finely pulverized ore may be shaken up with a solution of caustic potash, the solution filtered and acidulated with a strong acid; a yellow precipitate of sulphide of antimony will fall if the ore contains a sulphuret of antimony.

Antimonial galenas may be treated in such a way as to obtain the lead pure, or all the antimony combined with the lead at pleasure.

To obtain the lead only, the assay must be mixed with four times its weight of carbonate of soda covered with salt, lumps of borax placed on top, and treated in the furnace exactly as described in the first operation. No nails should be added.

To obtain the lead and antimony together, mix the assay with equal parts by weight of cyanide of potasium and carbonate of soda.

It is sometimes found to be economical and not objectionable to pour the assay into a small concave mold instead of breaking the crucible, which may be used for subsequent assays. This should never be done unless in cases where many assays are to be made of ore from the same mine.

WET ASSAYS OF FIRST CLASS ORES.

Assays of the ores of the first class may be made by the humid method as follows:

Pulverize the ore very finely, weigh ten grams carefully, boil in a flask with twenty C. C. of strong nitric acid on a sand bath until the ore is completely decomposed, and no more red fumes are given off. Pour out carefully into an evaporating dish and evaporate to complete dryness. Care must be taken in this operation that no violent spurting or decrepitation of the assay takes place by which any part may be lost. When the dry mass is cold it must be boiled with a strong solution of carbonate of soda. It should then be poured on a filter and well washed with distilled water. Dilute acetic acid is then cautiously added, by which it is dissolved, and passes through the filter into a clean beaker which must be placed to receive it. When the solution is complete, every portion of the solution must be washed from the filter with distilled water. Earthy matters remain in the filter.

If dilute sulphuric acid is now added to the contents of the beaker the whole of the lead is thrown down as sulphate, which may be placed on a weighed filter and thoroughly washed with distilled water and alcohol, dried at the temperature of two hundred and twelve degrees Fahrenheit, and weighed. The weight of the filter must be deducted from the weight obtained. The sulphate of lead contains 68.28 per cent of metallic lead. There are some sources of error to be avoided in this operation. If the precipitate is not thoroughly dried in the filter, correct results will not be obtained, neither will it do to heat the filter so hot as to char or partly burn it. It is better to take two filters made of the same paper, fold them together while cutting them, then separate them, place one in each pan of a balance, and carefully trim the heaviest with a pair of scissors until they weigh alike; fold them together again, put them in the funnel together, wash the precipitate on them, dry together in a steam bath, then separate them, place the one with the precipitate in one pan of the balance and the other in the other pan; the difference will be the weight of the precipitate. There is a method common with chemists of burning the filter and incinerating the ashes with the precipitate in a platinum crucible, at a red heat, but the conveniences are not found in ordinary assay offices. The details may be found in any work on quantitative analysis. With proper care, correct results may be obtained by drying the precipitate on the filter. In the process given above the following reactions occur:

First.—The nitric acid attacks the ore and oxidizes both the sulphur and the lead, forming sulphate of lead.

Second.—By evaporating to dryness, the excess of nitric acid is driven off, but leaving some nitrate of lead mixed with the sulphate.

Third.—The carbonate of soda decomposes the sulphate of lead, forming carbonate of lead and soluble sulphate of soda, which is washed out as directed with distilled water.

Fourth.—The dilute acetic acid poured on the filter decomposes the carbonate of lead and forms acetate of lead, which, being soluble, passes through the filter, leaving insoluble matter, if there be any, in the filter.

Fifth.—Sulphuric acid, being a stronger acid than acetic, combines with the lead, giving now the pure sulphate.

The calculation of the assay is made as follows:

It has been shown that sulphate of lead contains 68.28 per cent of metallic lead; it is clear that we must find that per cent of the sulphate of lead we obtain, which will be the amount of lead in ten grams of the ore. Suppose we obtain 7.46 grams of sulphate of lead in the ten grams of ore, then $7.46 \times .6828 = 5.09$ metallic lead. Ten grams yielding this (5.09), it is clear that 100 grams would yield ten times as much, which is the percentage. The result would then be as follows: Lead, 50.9 per cent.

ASSAYS OF CLASS TWO.

The assay of substances belonging to class two is very simple. Twenty grams of the ore is weighed out as in the case of assay of first class, ten grams of red argol and thirty grams of carbonate of soda are well mixed in the crucible, the whole covered with a layer of salt and tapped on the mixing table to settle all down. Put the crucible into an increasing fire and keep at low red heat for quarter of an hour. Then increase the heat until the contents of the crucible flow freely, tap gently and set it aside to cool, break the crucible, hammer the button into a cube and weigh. If arsenite of lead or sulphide of lead are present, use nails.

The humid assay of this class is made by heating ten grams of the substance to redness, and afterwards boiling it in a flask with dilute nitric acid (one part of acid to one-two of water by volume); when the action ceases pour the contents of the flask into an evaporating dish and cautiously evaporate to dryness, allow the dry mass to cool, add dilute nitric acid, gently warm for an hour, add water, boil, and filter. The solution now contains all the lead as nitrate; the precipitative washing and weighing may now be conducted as directed in humid assays of ores of the first class.

CLASS THREE—ALLOYS OF LEAD WITH OTHER METALS.

Alloys must be boiled with dilute pure nitric acid, the solution decanted from the precipitate, which must be washed with water and the washings added to the solution, which must then be filtered.

The solution may contain all the other metals likely to be present in alloys, except gold, platinum, antimony, and tin.

The solution (which should never be too dilute) must be mixed with dilute sulphuric acid slightly in excess. (This may be explained by stating that "excess" means the slightest quantity of reagent in excess of what is required to precipitate all of the lead.) The dilute acid should be added slowly, and the precipitate allowed to settle before further addition is made. When the sulphate of lead has all precipitated, double the volume of alcohol is added, and the whole set aside for a few hours to settle, after which it is decanted and washed into a small filter, washed with alcohol, and dried on a water bath, or in the sun. When the precipitate on the filter is perfectly dry, a clean piece of writing paper is spread on a table, and a small clean porcelain cup set in the center of it. The precipitate must then be carefully detached from the filter, and transferred to the cup. The dry filter is then held in a pair of small pliers over the cup, and burned by applying a match or candle flame; the ashes which fall on the paper must be brushed into the cup. The cup may then be placed on a piece of wire gauze, set on the ring of a retort-stand, and heated from below with a spirit lamp to a red heat. When cold, the cup and contents are weighed, and the tare of the porcelain cup deducted; the remaining weight will be that of the sulphate of lead obtained from the alloy.

The weight of the alloy taken for assay and the calculation are the same as in the last example.

When great accuracy is not required the use of alcohol may be dispensed with, but more excess of sulphuric acid must be used for precipitation, and the washing water must contain some dilute sulphuric acid.

RECEIPTS, MANUFACTURE, AND EXPORTS OF LEAD.

Although some of the mining districts of California abound in plumbiferous ores, lead mining as a distinct business has never been pursued in this State, nor have we here treated any ores of this class exclusively for the lead they contained. At the works of the Selby Smelting and Lead Company, located in San Francisco, large quantities of argentiferous galena have been reduced, but the ore was mostly obtained from the Castle Dome district, Arizona. So, also, at these works, have many thousand tons of lead-silver bullion been parted and refined, this bullion coming nearly all from the mines of Eureka, in the State of Nevada, or from the Cerro Gordo district, in California. This company turn out an average of about 6,000 tons of lead per year, one half of which is exported, and the remainder manufactured by them into sheet, pipe, shot, and other articles composed of lead, of which they supply about all that is required on this coast. For a number of years we exported to China about 5,000 tons of lead annually. Lately we have sent very little to that country, the market there being supplied now mostly from England.

THE COST OF MINING AND SMELTING.

For the benefit and guidance of those interested in mines producing smelting ore, we give some complete and authentic figures on the subject, furnished to the *Inyo Independent* by Mr. W. Belshaw, of the

Union Consolidated Mining Company, Cerro Gordo, Inyo County, California. These figures are taken from practical work and results, and are therefore of more than ordinary interest. The statement covers a period extending from February 1 to October 1, 1876:

Total cost of mining and reduction, including interest on capital, $198,525 84, viz.:

Mining expenses	$154,966 61
Furnace expenses	137,822 36
Interest expenses	5,736 87

Cost of mining 9,950 tons ore, $54,966 61, viz.:

Labor	$37,695 55
Water	1,871 79
Hauling ore	5,143 63
Powder and fuse	585 10
Candles	840 00
Wood	1,508 50
Blacksmithing	937 46
Timbers and lagging	1,505 22
Freights and sundries	2,379 36
Superintendence	2,500 00

Carbonates and oxides (soft ores)	8,220 tons
Estimated cost per ton for mining	$4 43
Sulphuret or galena ores	612 tons
Estimated cost per ton for mining	$10 00
Silver-bearing quartz ores bought and mined	1,118 tons
Estimated cost per ton	$11 00
Average assay of 8,220 tons	20 per cent lead
Average assay of 612 tons	70 per cent lead

WAGES AT MINE.

Foremen and engineers, per day	$5 00
Ordinary labor, per day	4 00

Mining Superintendent, J. L. Porter.

Cost of reduction of 9,950 tons of ore, $137,822 36, viz.:

Coal, 1,960⅗ tons, at $38 per ton	$74,405 28
Labor	31,339 87
Wood	4,067 12
Water	8,367 21
Blacksmithing	458 29
Freights	2,456 64
Superintendence	4,999 66
Paid men accidentally injured	474 35
House expenses	3,235 56
San Francisco office expenses	714 75
Stable expenses	761 38
Cerro Gordo office, legal, taxes, surveying, and sundry expenses	1,650 00
Tools, oils, and repairs	4,892 25

Cost per ton of ores, reduction	$13 85
Cost per ton of ores, mining	5 53
Cost per ton of ores, interest	58
Total per ton for mining and reduction	$19 96

WAGES AT FURNACE.

Engineers and chargers, per day	$5 00
Ordinary labor, per day	4 00

Superintendent of furnace, Hugh Morrison; Assistant Superintendent, Wm. E. Goodrum.

Total running time of furnaces, 331 days; tons of lead produced, 1,325—or 64 per cent of lead assay; 90 per cent of silver values saved.

Yours respectfully,

M. W. BELSHAW, Sup't Union Con. M. Co.

DIMINISHED RECEIPTS.

The rate at which San Francisco receipts of both lead and base bullion have fallen off during the last six years is shown by the following table, the amounts being expressed in pounds:

Years.	Base Bullion.	Lead.
1878	21,568,800	3,669,700
1879	11,926,500	1,815,000
1880	4,422,900	8,431,800
1881	4,344,600	12,114,000
1882	1,949,200	4,510,800
1883	1,634,800	1,470,400

The extension of mining operations in the southeastern part of the State will be likely to increase receipts of the above products at San Francisco hereafter. The low prices ruling for lead ($72 per ton of 2,000 pounds in the New York market), has had a tendency to restrict production everywhere, these being figures that leave little chance for profit to either the miner or smelter. As the Leadville ores are becoming much impoverished, the enormous output made for several years past at that great center of production must suffer serious curtailment in the future, causing a corresponding hardening in prices.

The Duty on foreign lead imported into this country in pigs, bars, etc., is two cents per pound; on lead manufactured into sheets, pipes, or shot, three cents per pound; a tariff that affords the domestic producer ample protection so far as the home market is concerned.

The Production of Lead in the United States, commencing a little over fifty years ago at the rate of about 1,000 tons per year, has gone on increasing since, till it reaches now about 140,000 tons—the product of 1882 amounting to 133,000 tons. The increase during the last twelve years, since the opening up of the Utah, Nevada, and Colorado mines, has been very rapid. Most of the lead formerly produced in this country was from the mines in Wisconsin, Missouri, and other Western States, which, for the ten years preceding 1849, had made an output varying from 15,000 to 25,000 tons per year. After 1850 the product in these Western States fell off rapidly, many of the miners having left for California. Prior to 1875 a good deal of lead was imported into the United States, as much some years as 40,000 tons—generally, however, much less; some years none at all. Since 1875 imports have dwindled to a small amount—less than 4,000 tons per year. The bulk of these importations has throughout, under the operation of the drawback provision in the law, been reëxported in the shape of solder on tin cans containing petroleum, fruits, etc.

WHITE LEAD.

The Pioneer Works of Whittier, Fuller & Co.—We have but a single establishment for the manufacture of white lead on this coast, that of Whittier, Fuller & Co., situated on Fremont Street, between Howard and Folsom, in this city. These works are very extensive, being five stories high, and reaching from Fremont to Beale Street, 275 feet. The acid works and corroding sheds, adjoining the main building, have a frontage of 185 feet on Fremont, whence they extend back 275 feet to Beale Street. The machinery, apparatus, and processes employed are as perfect, probably, as any in use; there being claimed for some of the processes here introduced a special excellence. About 250 tons of pig lead are consumed here monthly. From this quantity of metal there is made an equal amount of white lead, the product of these works going far towards supplying the entire demand of the coast. The lead worked up here is obtained mostly from Utah and Colorado, but little being now received from Nevada. There are employed in the different departments of this establishment about 120 men, some of whom are highly skilled in special lines of the business, such as making paints, grinding colors, etc. Besides white lead, this firm manufacture what is known as Pacific rubber paint. As everything connected with this industry—the lead, acid, linseed oil, packages, etc.—is the product of this coast, these works give employment, directly and indirectly, to a large amount of labor, besides retaining in the country considerable sums formerly sent abroad to purchase the commodities made here.

By reason of so much white lead of superior quality being turned out at these works, the imports of this article at San Francisco have of late years been small. The quantity of the white lead made in the United States during the year 1880 amounted to 123,477,800 pounds, valued at $8,770,699.

81. LENZINITE. Hydrous Silicate of Alumina.

"Mountain Butter" is found in cavities in rocks at the mouth of Pine Creek Cañon, Alabama Range, Owens Valley, Inyo County. (Aaron.) This mineral is probably Lenzinite.

82. LEPIDOLITE. Etym. *Scale Stone* (Greek). Lithium Mica.

This beautiful mineral has recently been found in California, at several localities, with erythrite and rubellite. It is a pink colored, scaly mineral, containing from 2 to 6 per cent of lithium. The California mineral has not yet been analyzed. It might, at some future time, be found profitable to extract lithium from it. The salts of lithium are principally used in fireworks and in medicine. The California localities are represented in the State Museum by Nos. 1229, San Diego County; 2773, twenty miles southwest of Colton, San Bernardino County; and 4262, with azurite, from the Half Dollar mine, Inyo County.

83. LEUCOPYRITE. Etym. *White* (Greek), and *Pyrite;* Arsenical Iron.

Said to occur in Los Angeles County, exact locality not given.

LIGNITE—see Mineral Coal.

LIME—see Calcite.

LIME GARNET—see Grossularite.

LIMESTONE—see Calcite.

84. LIMONITE. Etym. *Meadow* (Greek). See, also, Iron Ores.

This is a hydrous sesquioxide of iron, found sometimes compact and fibrous, at others earthy and dull. When pure, it has the following composition:

Sesquioxide of iron	85.6
Water	14.4
	100.0

Equivalent in metallic iron, 59.3 per cent. Limonite is sedimentary, and results from the weathering of rocks containing iron. It sometimes forms large beds in low marshy lands, and is known as bog iron ore. It also occurs in strata generally underlying gravel and clay, intimately mixed with fine sandy silt. When of a golden yellow color, it is called yellow ochre, in which form it is extensively used as a pigment. In both forms it is quite abundant in the State; in the former it is a valuable ore of iron, but more likely to contain sulphur and phosphorus than other iron ores. A large portion of the ore now being worked at Clipper Gap, Placer County, is limonite. Yellow ochre of most excellent quality is found at several localities in California. It was first discovered at Knight's Ferry, Stanislaus County, many years ago, and attempts were made to utilize it, but the market at that time was limited, and large stocks were held by the importers, who discouraged home production. The time has now arrived when it can be worked to advantage, and its production will retain considerable money in the State, and give remunerative employment to a few persons. Before yellow ochre can be used it must be submitted to a washing process to remove the sand and other impurities. This may be done on the ground, by the very simple process of breaking it up in a pug mill, such as used in brick making, or in a tub planned like an arastra, or silver mill separator. Whilst being agitated, water is allowed to flow in and out of the vat, and the outflow being near the top, the heavy sand and gravel, etc., is retained, the water carrying off only the fine ochre. Below the agitator a succession of vats, of convenient form and size, are arranged, through which the yellow muddy water flows. They should continue so far that the water will pass from the last one quite clear. The ochre will settle in the tanks, being finest in the one most distant from the agitator. When sufficient has accumulated the operation may be discontinued, and the yellow mud, which is the refined ochre, shoveled out and allowed to dry. It should be so fine that no grit can be felt when it is crushed between the fingers, and it should mix with oil to a smooth paint without grinding, which, when laid on, should show no sign of gritty particles. When yellow ochre is calcined it becomes red. The following localities of limonite are represented in the State Museum:

(2455.) Between Jenny Lind and Campo Seco, Calaveras County.
(3002.) Gold Lake, Sierra County.
(3760.) San Andreas, Calaveras County.
(3762.) San Luis Obispo County.
(3763.) Near Campo Seco, Calaveras County.
(3766.) Near Big Trees, Calaveras County.
(3774.) Twenty-five miles east of Visalia, Tulare County.
(4148.) Near Latrobe, El Dorado County.
(4907.) Five miles from Alameda, Alameda County.

YELLOW OCHRE.

(4010.) Near Campo Seco, Calaveras County. Bright golden yellow color.
(4011.) The same, calcined. It is a very deep rich red color.
(5301.) Yellow ochre of good color and quality, found in large quantities on Section 32, Township 12 north, Range 11 east, four miles east of Georgetown, El Dorado County.

85. LITHARGE. Etym. *Silver Stone* (Greek).

This substance has been found in San Bernardino County. It is probably a furnace product, made in prehistoric times. It has been found also in Arizona, in localities remote from the Missions, and under circumstances leading to the opinion that the furnaces, now obliterated, were erected and worked by the people who dug the irrigating canals, and built the Casa Grande, in the Valley of the Gila River, and lived in the ancient cliff dwellings.

LITHOGRAPHIC STONE—see Calcite.

86. LITHOMARGE. Etym. *Marl Stone* (Greek and Latin).

A fine grained hydrous silicate of alumina, probably sedimentary. It contains generally magnesia and lime. No. 423, in the State Museum, is from the Alpha mine, Table Mountain, Tuolumne County, called "pipe clay;" No. 2515 is from near the Big Trees, Calaveras County; and No. 4498 from Lassen County.

LOADSTONE. Natural Magnet—see Magnetite.

MACLE—see Andalusite.

MAGNESIAN LIMESTONE—see Dolomite.

87. MAGNESITE. Etym. *Magnesia* (Greek). Carbonate of Magnesia. ($Mg\ O, CO_2$.)

Magnesia	47.6
Carbonic acid	52.4
	100.0

H 3.5—4.5, sp. gr. 3. Color generally white, sometimes yellowish, with dark colored streaks. Fracture conchoidal, with sharp edges; dissolves in hot muriatic acid with effervescence. This valuable mineral, which is rather abundant, is used in the arts, principally in the manufacture of cements, and also as a convenient source of magnesia salts. There is a sample of hard artificial stone in the State Museum, No. 2791, thus described:

Artificial stone, made from magnesite, from Coyote Creek, near Madrone Station, S. P. R. R. The rock was calcined, pulverized, and mixed with solution of chloride of magnesium, made by dissolving a portion of the powdered rock in common muriatic acid to about the consistence of cream. This was used as a cement to unite broken rock into a kind of concrete. In this specimen broken marble was used, as being most convenient at the time.

The following is the *Hohlweg Process* for obtaining magnesium sulphate from crude mineral (patented June 6, 1882):

I take the crude mineral containing carbonate or silicate of magnesia, and reduce it to a fine powder, and mix with it, either when pulverizing or afterwards, about six times its weight of bisulphate of soda. The whole is placed in a tank, or vat, with a suitable quantity of water, in which condition it is kept for about twenty-four hours, and occasionally agitated by stirring the mass. By this means one equivalent of the sulphuric acid contained in the bisulphate of soda combines with the magnesia, from which action a mixture of sulphate of soda and sulphate of magnesia is obtained. To the resulting solution of sulphate of soda and sulphate of magnesia I add carbonate of soda in quantity required, to precipitate the magnesia from the solution as carbonate in the usual manner. Should iron be present in the mixture, this may be removed in the usual way, and the pure sulphate of magnesia may be obtained from the solution by successive evaporation and crystallization, the sulphate of soda having first been removed by evaporation and crystallization, and afterwards the sulphate of magnesia.

While carbonate of magnesia is found at numerous localities in the State, the following are the most important: On Coyote Creek, about two miles from Madrone Station, S. P. R. R., Santa Clara County, near the road is a large deposit; Nos. 1195 and 5159 are from Gold Run, and Damascus, Placer County, where it occurs in large quantities; No. 3025 contains silica, and under the microscope shows a cryptocrystalline structure; it is from a vein two feet wide on Arroyo Seco, Monterey County.

The following localities are given by W. P. Blake:

Tulare County, near Visalia, between Four Creeks and Moore's Creek, in solid beds of pure white massive carbonate of magnesia, hard, fine grained, and like unglazed porcelain in texture. The beds are from one to six feet thick, and interstratified with talcose slates and serpentine. Similar beds are described to me as existing in the Diablo Range, Alameda County, about thirty miles south of Mount Diablo.

Mariposa County and Tuolumne County.—A heavy bed of magnesian rock, chiefly magnesite, charged with crystals of iron pyrites, accompanies the chief gold-bearing quartz vein of those counties. This rock is charged also with nickel and chrome talc in green films, like the magnesite of Canada.

No. 4675 is an artificial carbonate of magnesia, obtained as a by-product in the tanks, in working the mother liquors from the manufacture of salt, by the Union Pacific Salt Company, Alameda County, and largely used in the manufacture of explosives.

Magnetic Pyrites—see Pyrrhotite.

Magnetic Sands—see Magnetite.

88. MAGNETITE. Etym. *Magnesia Stone* (Greek). Magnetic Iron Ore. (FeO, Fe_2O_3.)

Protoxide of iron	31.03
Sesquioxide of iron	68.97
	100.00

Equivalent to:

Iron	72.4
Oxygen	27.6
	100.0

H=5.5—6.5, sp. gr.=4.9—5.2. Color and streak, black; opaque, brittle; attracts the magnet, and deflects the magnetic needle strongly; frequently it possesses polarity, in which case it repels the magnetic needle and attracts soft iron in small fragments; it is then called natural magnet, or loadstone. Magnetite takes its name from Magnesia, a town in Asia Minor, where it was first discovered by the ancients; and it is stated that a shepherd, while herding his sheep, observed that the iron ferrule of his staff and the nails in his shoes adhered in some places to the ground, which led to its discovery. The words magnetic and magnetism have the same derivation. It is said that the first mariner's compass of the Chinese was a fragment of loadstone, floated on a cork in a vessel of water. Advantage is taken of the magnetism of ores of iron by using a dipping needle in searching for them. As the prospector passes over the ground, the downward deflection of the needle indicates bodies of iron ore beneath the surface. Magnetite is a valuable ore of iron, and exists with other ores in numerous localities in California. The following are known localities, arranged by counties:

Amador County. Two miles northeast of Jackson, magnetic sand, with pyrite. No. 65, Sutter Creek.

Butte County. With native copper, in the Lincoln Tunnel. No. 2788, Ball Creek, near Oroville.

El Dorado County. Volcanoville (Blake). Crystals in slate, near Boston copper mine, and with quartz and pyrite, Excelsior copper mine (Blake). No. 965, two miles northwest of Shingle Springs. No. 1667, near Big Red Ravine, two miles from Coloma. No. 4254, Clarksville.

Inyo County. Magnetite is found in a number of localities in the Inyo Mountains. Fine specimens of loadstone have lately been sent to the State Mining Bureau, from the Slate Range, where it exists in quantity.

Los Angeles County. In the Canada de las Uvas there is a vein, three feet thick, in limestone (Blake). No. 4644, thirty miles north of Los Angeles.

Mariposa County. East of the Mariposa estate (Blake). No. 1996, near Coulterville. No. 3005, base of Mount Hoffman.

Mono County. In a vein, five miles south of Benton, with steatite and gold (Aaron). No. 3639, Indian district. Analysis by Falkenau & Reese: Peroxide of iron, 93.00; silica, 7.00; total, 100.00; graphite and sulphide of copper, traces. No. 3768, near Benton. Analysis by Falkenau & Reese: Peroxide of iron, 93.00; silica, 7.00; traces of sulphide of copper. This ore is said to be in very large quantities. Loadstone. Spur of White Mountains, half a mile south of Montgomery (Aaron).

Napa County. No. 3757, near St. Helena.

Nevada County. No. 4569; magnetic sands with gold and pyrite, concentration from hydraulic mines. No. 5767, Grass Valley.

Placer County. Utt's Ranch (Blake). Near New England Mills. No. 1333, six miles from Auburn, large deposit. No. 1938, Section 15, Township 13 north, Range 8 east.

Plumas County. (After pyrite) Armentine mine, with epidote and garnet (Blake). Mumford's Hill (Edman). No. 117, near Gold Lake, line of Plumas and Sierra Counties. No. 3361, with hematite, near Crescent Mills.

San Benito County. No. 819, Tres Pinos. No. 2274, Coast Range Mountains. No. 4344, fourteen miles from Hollister, in large quantities with limestone.

San Diego County. No. 2886, eight or nine miles north of Mesquit Station.

Santa Barbara County (Trask).

Santa Cruz County. Near the town is an extensive bed; the needle deflected 31 degrees on approaching it (Trask).

Shasta County. At Iron Mountain, five miles from the Sacramento River. Altitude above river, 1,300 feet. An abundance of wood at $2 50 per cord, and plenty of water at the mine. Analysis by Kellogg, Hewston & Co.: Protoxide of iron, 11.58; sesquioxide of iron, 80.15; alumina, 1.69; silica, 4.95; water, 1.63. No. 20, McCloud River. Nos. 1761 and 4383, Potter's iron mine, seven miles from Shasta. No. 4139, in octahedral crystals, exact locality not known.

Sierra County. In large beds (Blake). No. 3756, Mohawk Valley, Sierra Iron Company.

Sonoma County. No. 4238, mouth of Russian River; magnetic sands.

Trinity County. Near Weaverville (Trask).

Yuba County. No. 579.

89. MALACHITE. Etym. "*Mallow.*" Green Carbonate of Copper, Mountain Green. (CuO, CO_2+CuO, HO.)

Protoxide of copper	71.9
Carbonic acid	19.9
Water	8.2
	100.00

Equivalent of copper, 57.39 per cent. H=3.5, sp. gr. 3.7—4. Color bright green; streak paler. It dissolves in acids with effervescence, the solution becoming bright blue if ammonia is added in excess. B. B. on ch. fusible, a globule of copper is easily obtained. In a closed tube it blackens and yields water. This mineral is valuable as an ore of copper, but still more so as an ornamental stone when found in masses of sufficient size. Magnificent vases, tables, and mantels of malachite were shown in the Russian department of the Paris Exposition of 1878. The same objects had been exhibited at previous World's Fairs. While malachite has been found in numerous localities in California, it has never been obtained in sufficient quantity to be used for ornamental purposes. Malachite when ground and properly washed has been somewhat used as a pigment under the name of "Mountain Green," but it is not so good for that purpose as some of the artificial greens.

CALIFORNIA LOCALITIES.

In remarkably fine specimens, associated with crystalline blue carbonate, at Hughes' mine, Calaveras County (Blake). At Alisal, Monterey County (Trask). Santa Rosa Creek, San Luis Obispo County; San Emidio Ranch, Kern County, with melaconite. Copperopolis, Calaveras County; Del Norte County; Plumas County, with azurite, gold, and quartz. Whitman's Pass, Tuolumne County. No. 672, with cuprite, azurite, and chrysocolla, in the Lost mine, thirty miles west of the Colorado River, San Diego County. No. 816, Peck mine, Copper Hill, Shasta County. No. 4746, with azurite, cuprite, and partzite, in the Kerrick mine, Blind Springs, Mono County; also at a number of localities in the Inyo and Coso Mountains.

MALTHA—see Petroleum.

MANGANESE OXIDE—see Pyrolusite.

90. MARIPOSITE. *Mariposa County.* (Provisional name.)

This is a mineral of an apple green color, found with quartz, on the Mariposa estate, Mariposa County; and elsewhere on the great mother lode of the State. It has not yet been fully determined. It is referred by Dana to fuchsite. It was first described by Prof. Silliman, December 2, 1867: see Proceedings of the California Academy of Sciences, vol. 3, fol. 380. It is represented in the State Museum by No. 1295, from the Josephine mine, Mariposa County.

MARBLE—see Calcite and Building Stones.

91. MARCASITE. Etym. ancient name for *Pyrite* (Arabic or Moorish origin). Sulphide of Iron, White Pyrites.

This mineral has the same composition as pyrites, but is of a white color. It is put to the same uses, such as making sulphur, sulphuric acid, etc. It is quite common as an associate of gold in California with pyrite (yellow colored), chalcopyrite, galena, sphalerite, mispickel, etc.

92. MELACONITE. Etym. *Black* (Greek). Black Oxide of Copper.

This is a rare mineral in California. It is said to occur with malachite at the San Emidio ranch, Kern County. No. 812 is from the Afterthought mine, Shasta County. Melaconite occurs in the Satellite copper mine, formerly the Lancha Plana, near Campo Seco, Calaveras County, in masses of considerable size, with bornite, and containing granules of metallic copper the size of bird-shot. In the R. F. with chloride of ammonia it imparts an intense blue color to the flame. It is partly soluble in hydrochloric acid and is decomposed in nitro-hydrochloric acid with the separation of sulphur. This mineral occurs in nodules black and earthy inside but covered with a white incrustation.

93. MENACCANITE. Etym. *Menaccan,* in Cornwall, England. Ilmenite, Titaniferous Iron.

A single but fine crystal was found in the gold washings near Georgetown, El Dorado County. It was about an inch in diameter with brilliant planes (Blake). Fine specimens are brought from Bill Taylor's ranch near Buchanan, Fresno County, twenty miles south-east of Mariposa. No. 2731 is from this locality.

MERCURY—see Quicksilver.

94. METACINNABARITE. Etym. *Beyond* (Greek) and *Cinnabar*.

This rare mineral is a black sulphide of mercury, described by G. E. Moore in 1870. It resembles cinnabar in composition, being like that species (Hg S), but differs from it in color, streak, specific gravity, and luster. It corresponds to the black sulphide of mercury produced artificially by mixing the elements; while cinnabar conforms to the artificial sulphide obtained by sublimation. It occurs with cinnabar and native mercury in several quicksilver mines in California, and has lately been found in Oregon. It has never been obtained in large quantities like cinnabar, and is still considered a rare mineral. When first found it was generally thought to be amorphous, but it has since been found beautifully crystallized in the Redington mine, Napa County, the locality where it was first discovered. Fine specimens have been obtained in the Great Western mine, Lake County; in the California mine, Yolo County, No. 448, amorphous, and No. 540 in crystals; and in the Bonanza mine, Douglas County, Oregon, associated with cinnabar, No. 4455.

95. METEORIC IRON.

Meteoric iron is of cosmical origin, having fallen to the earth from space. There are numerous theories as to the source from which these bodies come, but the question is far from being solved. Every new meteorite is studied, with a view to gain additional information upon this very interesting subject. The fall of aerolites has been observed from the earliest historical times, and regarded with awe and wonder. It is a singular fact that meteorites contain the same elements that are found on the earth; twenty-two of the known elements having been found in aerolites, the principal ones being iron, nickel, hydrogen, cobalt, silica, manganese, and aluminium. Some meteorites are found to have absorbed a large quantity of hydrogen gas in their passage through space; but although a few combinations are found which have not been observed in terrestrial matter, no new element has as yet been discovered in any of them. Meteoric stones are classed in two groups: those containing metallic iron (siderites), and those which do not—*stony* meteorites. These groups are again subdivided.

The iron meteorites have the singular property of developing or revealing crystalline structure when a smooth surface is acted on by dilute nitric acid. These crystals are called Widmannstattian figures, from the name of the discoverer. Some aerolites show this crystallization without etching, as is the case with both of those in the State Museum, to be described. In 1866 Dr. Trask found a small fragment of iron in Honcut Creek, Butte County. It had the appearance of cast iron, and was pronounced by Professor Brush not to be meteoric. Still it was considered remarkable at the time, that a fragment of cast iron should have been found under the circumstances, and it is a little singular that a similar fragment has been recently sent to the State Mining Bureau which was found on the bedrock, near Columbia, Tuolumne County. At a meeting of the California Academy of Sciences, February 19, 1866, Professor Whitney stated that Dr. J. G. Coffin had found fragments of iron in the bed of the Mohave River. At that time no meteorite had been found in California that was known to be such.

There was a rumor, a number of years ago, that there was a large mass of meteoric iron on the line of travel up the coast, a few miles north of Crescent City, Del Norte County, but it could never be traced to any reliable source. The El Dorado meteorite was found at Shingle Springs, by a blacksmith whose name is not given. It was noticed by J. H. Crossman in 1871, and placed in the cabinet of W. V. H. Cronise, where it was seen and described by Professor B. Silliman, in the *American Journal of Science and Arts* for July 18, 1873, with a figure from a photograph by Watkins of San Francisco. A short notice of it by Professor C. U. Shepard of Amherst College, appeared in the same journal of June, 1872. The weight of this meteorite was about eighty-five pounds avoirdupois. Its largest dimensions were twenty-four and twenty-nine centimeters; density, 7.875. No Widmannstattian figures were developed by etching.

The following analysis of it by J. A. Cairns, of the School of Mines, Columbia College, New York, is published:

Iron	81.480
Nickel	17.173
Cobalt	.604
	99.257

With the following elements in small proportions: aluminium, calcium, carbon, chromium, magnesium, phosphorus, potassium, sulphur.

Professor Shepard arrived at quite different results, viz.:

Iron	88.02
Nickel	8.88
Insoluble	3.50
	100.40

This meteorite still remains in San Francisco.

The *San Bernardino Meteorite*, No. 2339, State Museum, was found in 1880 in the Ivanpah mining district, San Bernardino County, by Stephen Goddard. The weight, before cutting, was 1,870 troy ounces. Dimensions: length, 13.5 inches; width, 9.7 inches; thickness, 8 inches. Specific gravity of the mass, 7.693. It is an irregular body or mass of malleable iron. The surface is covered with concave cup-like depressions, some of which have considerable depth. The fine Widmannstattian figures on the cut face were developed by the action of nitric acid, and the smooth rim or border was protected from the action of the acid by wax, and should not be mistaken for a crust or outer shell. On one end of the aerolite may be seen distinct crystals corresponding to those developed by acid. Photographs, on a scale of one third the actual size, were taken of this specimen, both before and after cutting. Lithographs from these photographs are published with this report. The following analysis was made in the University of California by Mr. Gustav Gehring:

University of California, Berkeley, May 17, 1884.

Analysis of the San Bernardino Meteorite by Gustav Gehring, Assistant in Chemistry in the University of California:

Iron	94.856
Nickel	4.469
Cobalt	.261
Silica	.041
Sulphur	.004
Phosphorus	.002
Carbon in combination	.115
Graphite	.067
	99.815

Hardness, 3.75; specific gravity, 8.076.

The *Chilcat Meteorite*, No. 2925, State Museum, was purchased by the State Mining Bureau from Chief Donawack. It is from Portage Bay, Chilcoot Inlet, Alaska. Its weight is 1,410 troy ounces, or about 96¾ pounds avoirdupois. The State is indebted to the Northwest Trading Company, and to J. M. Vanderbilt in particular for negotiating its purchase, and to John Muir for calling attention to it. No analysis of it has yet been made, but a small fragment treated with acid developed Widmannstattian figures.

PLINY'S NATURAL HISTORY.

Book 2, Chapter 59, "Of stones that have fallen from the clouds." The opinion of Anaxagoras respecting them:

The Greeks boast that Anaxagoras, the Clazomenian, in the second year of the 78th Olympiad, from his knowledge of what relates to the heavens, had predicted, that at a certain time, a stone would fall from the sun. And the thing accordingly happened in the daytime in a part of Thrace, at the river Ægos. The stone is now to be seen, a wagon-load in size, and of a burnt appearance; there was also a comet shining in the night at that time. But to believe that this had been predicted would be to admit that the divining powers of Anaxagoras were still more wonderful, and that our knowledge of the nature of things, and, indeed, everything else, would be thrown into confusion, were we to suppose either that the sun is itself composed of stone, or that there was even a stone in it; yet there can be nó doubt that stones have frequently fallen from the atmosphere. There is a stone, a small one, indeed, at this time, in the Gymnasium of Albados, which ou this account is held in veneration, and which the same Anaxagoras predicted would fall in the middle of the earth. There is another at Cassandria, formerly called Potidæa, which from this circumstance was built in that place. I have, myself, seen one in the country of the Vocontii, which had been brought from the fields only a short time before.

96. MICA. Etym. "*A Crumb* or *Grain*" (Latin). Isinglass, Muscovy Glass, etc.

This name is not confined to a single mineral, but is applied to a group, the members of which are silicates of a variety of bases; all having a cleavage parallel with the base of the crystal. This cleavage is so perfect that the mineral can be divided into sheets thinner than paper. It is to this property, and their transparency, that they owe their value in the arts. The minerals most characteristic of the mica group are Biotite, Phlogopite, and Muscovite.

There seems to have been a confusion in the use of the name mica among the earlier mineralogists; they applied the term to any mineral which could be separated into scales or lamina, regardless of its composition. Mohs, in his treatise on mineralogy, includes a number of minerals which are not now placed in the mica group, as follows: "Euchlore mica," hydrous arseniate of copper; "Cobalt mica," arseniate of cobalt, erythrite; "Iron mica," phosphate of iron, vivianite, and micaceous iron ore; "Graphite mica," foliated graphite; "Talc mica," chlorite; "Uran mica," phosphate of uranium, torbernite.

In the second annual report of the State Mineralogist, folio 225, considerable space was given to the description of mica, and of the specimens in the State Museum at that time. No new localities have since been found which have any importance. The following is a quotation from the paper mentioned:

In crossing certain streams or rivers flowing in shallow sandy beds, quartz sand may be seen to roll forward beneath the water, remaining near the bottom; but particles of mica, frequently of a golden color, rise with the force of the stream to the surface, and glitter and gleam in the sunlight like particles of gold, for which they have often been mistaken. This peculiarity of mica was frequently noticed in the Platte River by the early emigrants to California, and by those who had discovered the mistake it was called *"Fools' Gold."*

There is a specimen of yellow mica schist, No. 1626, in the Museum of the State Mining Bureau, from a large deposit, which caused the Gold Lake excitement, and it is so like the precious metal in appearance that it is not surprising the mistake should have been made. With the advancement of invention there has been created an increased demand for mica, which has raised the price to that extent that a deposit of the best quality would be very valuable to the finder.

Mica is made a substitute for glass in certain cases where that material cannot be used, as in front of stoves, bakers' ovens, furnaces, certain lanterns, lamp chimneys, windows in ships of war, as such windows cannot be broken by the concussion of the guns. In chemistry it is sometimes used as a support for substances to be fused, and as thin covers for microscopic objects where it is desirable to have the cover thinner than can be attained by glass; it is also used in the pans of the balance upon which to place powders and damp or corrosive substances to be weighed. In this case two pieces of equal size and weight are used, which counterpoise each other.

Mica is also applied to ornamental purposes. In paper hangings and decorative work it is ground or otherwise separated into a fine scaly powder and sifted over the work in a kind of frosting, which is made to adhere by a coating of glue size or paint. Mica of a yellow color is said to be used in the manufacture of artificial aventurine.

Mica, being a constituent of granite, gneiss, and other of the more common rocks, is one of the most abundant minerals in nature. But it is only when it occurs separate and alone, and under other peculiar conditions, that it possesses any special value. Mica, in sheets or plates of the size and quality that adapt it for the uses to which it is mostly applied, is a mineral that, where the conditions are favorable, can be mined with profit. Nevertheless, much misapprehension seems to exist among miners as to the requirements of the trade and the prices usually paid for this mineral; the idea having obtained among this class that mica is so scarce and in such demand, that there is always a market for it at extravagantly high figures. But this is a mistake; it is only sheets of superior quality and extra large size, such as are rarely found, that meet with ready sale at high prices. Owing to the erroneous notions entertained on this point, the several attempts that have been made at working the mica deposits of California and Nevada have resulted in disappointment and loss, the parties who engaged in these enterprises having failed to realize for their product such prices as they had counted upon, chiefly because it did not quite meet the wants of purchasers. The outlook for this industry is, however, by no means desperate, as there are many promising deposits of mica in California, and elsewhere on the coast, and there is a chance that the quality of the article will improve when the mines come to be opened to greater depths.

WHERE FOUND.

The following include the principal localities at which this mineral has been found in California: At Gold Lake, Plumas County; in El Dorado County; Ivanpah district, San Bernardino County; near Susanville, Lassen County; and at Tehachipi Pass, Kern County; it having been observed at many other places in the State. As little or no work has been done on any of these deposits, not much can be said in regard to their probable value, one way or the other. We have reports of mica being found in nearly all the Pacific States and Territories; also in those contiguous to the Rocky Mountains; its occurrence in some of these being abundant, and extending to many different localities.

Micaceous Iron—see Hematite.

97. MILLERITE. Sulphide of Nickel.

This mineral is brass-yellow, resembling chalcopyrite. It is not a common or abundant mineral, and in California has been observed only at one locality—No. 3958, found half a mile from Cisco, Placer County.

98. MINERAL COAL. Lignite, Anthracite, Ionite, etc.

COAL—ITS OCCURRENCE IN CALIFORNIA AND ELSEWHERE ON THE PACIFIC COAST—PRODUCTION, CONSUMPTION, PRICES, ETC.

Possessing important minerals in great variety and abundance, California has not yet shown such wealth of coal as is much to be desired and as it is to be hoped the future will reveal. Deposits of this fuel occur at many places in the State, some of them being quite heavy, but none consisting of the better varieties of coal. Our coal is a lignite, answering very well for making steam and for domestic uses, for which, being comparatively cheap, it is largely employed. But thus far there has been found in the State no anthracite, coking, or even first class bituminous coal. Our domestic supplies have from the first been nearly all obtained from the Mount Diablo mines, which, opened up in 1860, have since turned out a yearly average of about 100,000 tons.

WHAT WE PAY FOR COAL.

The fossil fuels are among the staples for which we have always been obliged to pay high prices, whether required for forging iron, making gas, generating steam, cooking our food, or warming our houses. For whatever purpose employed this fuel has sold in the San Francisco market at an advance of nearly 100 per cent on eastern prices. Where the consumer almost anywhere east of the Mississippi has had to pay from $4 to $6 per ton for coal, we have had to pay for a like article from $6 to $13; the rates ruling at present and which have for some time past obtained in this market being shown by the following table:

	October, 1882.	October, 1883.
Australian	$6 25	$7 25
Liverpool	6 75	7 25
West Hartley	7 50	8 25
Scotch Splint	7 00	8 00
Lehigh	12 50	13 00
Coos Bay	6 50	7 50
Seattle	6 75	7 50
Mount Diablo	6 50	7 50
Wellington	9 00	10 00

With us the price of foreign coal depends somewhat upon the amount of shipping required for carrying away our wheat crop. If this be large, vessels coming here to load with wheat, in the absence of other lading, bring coal at low rates, taking it sometimes as ballast. Not always, however, have these low freights inured to the benefit of the consumer, local dealers combining very often to control the market and so keep up prices.

WHERE WE OBTAIN OUR SUPPLIES.

With the exception of some small lots taken from mines in the interior of the State, we procured our supplies of coal for the two years stated from the sources and in the quantities below set forth:

Where From.	1883. Tons.	1882. Tons.	Increase. Tons.	Decrease. Tons.
Foreign.				
Australia	150,318	158,901	----------	8,583
English and Scotch	155,102	188,771	----------	33,669
British Columbia	117,822	157,762	----------	26,994
Eastern.				
Anthracite	26,725	24,996	1,729	----------
Cumberland	16,555	14,860	1,695	----------
Domestic.				
Mount Diablo	76,162	113,255	----------	37,093
Coos Bay	24,525	14,533	9,992	----------
Seattle	164,986	154,611	10,355	----------
Carbon Hill (Tacoma)	137,420	54,627	82,793	----------
Chili	----------	580	----------	----------

California's consumption of coal the current year will be somewhat larger than that of 1883, owing to various new industrial establishments having been started, some requiring it for furnaces and forges, and nearly all for making steam. The supplying sources continue the same, with an enlarged production from the British Columbia, the Carbon Hill, and the Coos Bay mines, and a falling off in the product of the Seattle mines; the Mount Diablo showing the same output this year as last. Our importations of coal from Australia, the United Kingdom, and the Eastern States have been much less thus far the current year than usual. We append table showing receipts at San Francisco during the first six months of 1884:

Where From.	Tons.
Australia	49,345
English, Scotch, and Welsh	42,843
British Columbia	60,000
Eastern (Anthracite and Cumberland)	16,445
Seattle	65,318
Carbon Hill (Tacoma)	74,835
Mount Diablo	38,000
Coos Bay	37,596

The diminished receipts of foreign coal, as above shown, have been due to the following causes: Australia has this year a large wheat crop to move; hence, few vessels have arrived at this port from that country bringing coal. The dry weather that prevailed early in the year having threatened California with a short wheat crop, English ships, the usual carriers of coal, were deterred from coming here to load with that cereal; as a consequence, we are without our usual supply from that source, with prices meantime well maintained. More favorable weather later in the season having insured us an abundant yield of wheat, fleets of vessels will be attracted here from abroad, bringing, no doubt, their usual complement of coal. The prospect, therefore, is that the prices now ruling for the foreign article will recede before the year is ended.

THE COAL MINES OF CALIFORNIA—THE MOUNT DIABLO GROUP.

The only coal mines in California that have been worked to any extent and with even the smallest profit, are those included in the Mount Diablo coal field, a belt extending for ten or twelve miles along the northerly slope of Mount Diablo. All the mines, however, that have here been profitably worked, are included in a section of this belt, reaching not over two and one half miles along its western portion, and extending from the workings of the Black Diamond to those of the Pittsburg Company. The principal veins here consist of two, the Black Diamond having forty inches of coal, and the Clark having thirty-four inches, two small veins, the one having about a foot and the other five or six inches of coal, lying between them. Several other seams traverse the formation, but they are all too small to be of any value. While a great deal of money has been expended in this region prospecting for coal, only in a few instances have deposits sufficiently heavy been developed to warrant their being worked. The only companies that are now making, or ever have made, any considerable production here, are the Black Diamond and the Pittsburg, there being one or two others that are at present operating in a limited way. The Eureka, the Independent, the Union, the San Francisco, the Peacock, and the Stewart, or Central, are all among the mines that have been extensively exploited, but to so little purpose that work was suspended upon them many years ago. Since then, the most of them have filled with water, and having been dismantled, may now be considered practically abandoned. The developments made in the Empire and the Rancho de Los Maganos, are such as have served to keep life in these properties, which will ultimately, no doubt, be brought into a productive condition.

The trouble with these Mount Diablo mines is twofold—the coal, in the first place, is of an inferior quality, and then the cost of extraction is great, the beds being small and much disturbed by faults and dislocations. Mr. W. A. Goodyear, who several years since examined these deposits with great care, in remarking on this feature, observes that within the two and one half miles of profitable working, some seven or eight faults of considerable extent occur, involving throws of from ten to one hundred and fifty feet each, while immediately outside this section are disturbances of still greater magnitude, lesser but well marked dislocations being extremely numerous in these mines. The cost of mining and placing this Mount Diablo coal in San Francisco has averaged at least $5 per ton of 2,240 pounds, the cost of mining alone having averaged over $3 per ton.

The following table shows yearly receipts at San Francisco of coal from the Mount Diablo mines, from the time they were first opened to date, the quantity received during the first six months of 1884 being estimated:

Years.	Tons.	Years.	Tons.
1860	-------	1873	171,741
1861	6,620	1874	206,255
1862	23,400	1875	142,808
1863	43,200	1876	108,078
1864	50,700	1877	96,172
1865	60,530	1878	122,034
1866	84,020	1879	134,435
1867	109,490	1880	158,723
1868	132,537	1881	114,000
1869	148,722	1882	102,356
1870	129,761	1883	76,162
1871	133,485	1884 (first half)	38,000
1872	177,232		

Adding to the above ten per cent for coal sent from the mines to other points than San Francisco, and fifteen to twenty thousand tons to represent output of the Ione, Lincoln, and various other small mines in the State, we have the total product of the California coal mines up to this time; the other sources from which we have been accustomed to obtain our supplies of this fuel being sufficiently indicated by the tables already given.

OTHER DEPOSITS IN THIS STATE.

Of the other localities in California at which coal or lignite deposits have been found, outside of the Mount Diablo field, the following may be noted: In Ione Valley, Amador County, where the bed, which lies near the surface and can be easily worked, varies from five to fifteen feet in thickness. Although this deposit was discovered prior to 1870, and worked in a small way for several years thereafter, not until 1877 was much coal taken out, the product that year having amounted to 3,458 tons. From that time on not much was done here until 1883, when the mine began to be again actively worked, from forty to sixty tons per day having since been extracted. While this coal has been found to answer for making steam for general purposes, it does not answer for locomotives, the Central Pacific Railroad Company, after a trial of it on their engines, having discontinued its use. That company several years ago constructed a railroad from Galt to these mines, a distance of twenty-two miles, in the expectation that this coal could be used to advantage on their locomotives. Through its failure to do so the company sustained a heavy loss. All the coal now being taken out at this place finds ready sale at remunerative prices, being used by the flouring mills and other industrial establishments in the vicinity, and also to some extent on the steamers running on the Mokelumne, Sau Joaquln, and the Sacramento Rivers.

Shortly after the opening up of this Ione bed a similar deposit of coal was discovered at the town of Lincoln, in the southwestern part of Placer County. After some attempts at working this deposit operations were suspended, the coal proving to be of very poor quality. After remaining idle for some years, a new shaft was put down, which not only developed a thicker vein but a better quality of coal. Since this strike several carloads have been taken from the mine daily. Though a rather poor article, it finds a market, as it answers tolerably well for making steam and as an ordinary fuel. The owners are sinking a third shaft on the vein, with a view to facilitating the work of extraction. This mine is favorably situated for shipping its product, being within a few hundred yards of the California and Oregon Railroad.

More than twenty years ago a coal field was discovered and partially explored at Corral Hollow, in the hills to the south of the Livermore Pass. Many shafts were sunk, tunnels driven, and much money expended here, without developing any valuable bodies of coal, and the locality has for many years past been abandoned. At the time these deposits were being actively explored, the Western Pacific Railroad Company laid down a track from Ellis Station to the mouth of Corral Hollow, in the hope of being able to get coal here for their locomotives; a hope in which they were disappointed.

RECENT DISCOVERIES MADE AND REPORTED.

Among recent discoveries of coal in this State is the deposit known as the McIntosh and Cheney mine, situated in San Diego County, 4½ miles from Laguna Station, on the California Southern Railroad. The developments made here consist of a tunnel started on the easterly slope of the mountain in which the deposit occurs, and which, when 40 feet in, struck a vein of lignite 4½ feet thick. This tunnel was carried forward 206½ feet further, all the way in a bed of coal, which at this point measured 7 feet 3 inches in thickness, being of uniform quality and solid throughout. As this tunnel was advanced samples of the coal were taken for assay, one of which was made by the State Mineralogist. These assays showed it to contain, of fixed carbon, from 35.35 to 46.82; volatile matter, 30.40 to 40.27; water, 10 to 23; ash, 5.36 to 11.25; this being very similar to the Mount Diablo and Coos Bay coal. Several hundred tons of it sold at the mouth of the tunnel, to consumers in the neighborhood, is said to have given general satisfaction. As it can be broken out readily and without the use of powder, one man extracting several tons per day, it is sold at low prices. Thus far the cost of mining this coal has been $1 50 per ton; but with better facilities for performing the work, it can probably be delivered at the mouth of the tunnel for a third of that sum. Should this find turn out as well as expected, it will prove of great advantage to that section of the State, which, scantily supplied with wood, has still large fuel requirements, which have heretofore been met in good part by coal brought from British Columbia and Puget Sound. An ample supply of good coal from local sources would be to Southern California a matter of great economic importance.

A vein of coal 6 inches thick was discovered last year at a point about 25 miles from the town of Bodie, Mono County. Tested in the miners' stoves, this coal is represented to have burned freely with a steady flame, throwing out much heat. The deposit occurs in a sandstone formation, and though not yet opened up to any extent, is spoken of hopefully by parties who have seen it. The country in the vicinity abounds with mines, and being but sparsely wooded, the discovery of a tolerably good coal, even in moderate quantities, would help its prospects very much.

The finding of encouraging coal signs about four miles from Fulton Wells, Los Angeles County, was announced not long since. Though not yet developed, this find is said to be one of much promise; the vein discovered being several feet thick, and consisting of a bituminous coal, that burns freely in an open grate. Indications denote for this bed a considerable extent, a similar outcrop appearing across the range south of Spadra, seven miles distant. This would carry it through the rolling Puente hills, affording excellent facilities for opening up the bed, and giving a railroad near to and on each side of it. The work of further exploring this deposit will be awaited with interest.

Coal signs, and in somes cases deposits of considerable extent, have been met with at many other places in California; but only on a few of these has much exploratory work been done. In good time they will all be examined with more care, resulting, no doubt, in greatly enlarging our stock of the fossil fuels.

According to Mr. Goodyear, already quoted, a bed of coal, from 14 to 15 feet in thickness, has been exposed on the Middle Fork of Eel River, eight miles south of the village of Round Valley, in Mendocino County. While this coal occurs here in such quantity, and is of good quality, Mr. Goodyear expresses the opinion that very little of it will ever be likely to reach the San Francisco market, for the reason that the rocks in the neighborhood have been so much disturbed, that the bed will probably prove to be much crushed and broken up by faults; while the locality, being in the heart of the Coast Range, could be reached only by a railroad for a long distance over a rough country. In addition to the above, veins of coal, generally of sufficient thickness to suggest for them some value, have been observed at the following localities in this State, viz.: In the hills south of Vallecitos, 6 miles westerly from the New Idria quicksilver mines, Fresno County; on Los Gatos Creek, easterly flank of the Coast Range, same county; in the foothills of the Sierra Nevada, eastern part of Shasta County, where the coal outcrops over a considerable area; at American Cañon, in the southwestern part of Solano County, along the face of a steep bluff; the coal signs here not, however, being in place; in the range of hills east of Santa Rosa Valley, Sonoma County; and at many places in the Coast Range besides those mentioned; the most encouraging indications being met with in Santa Cruz, Monterey, Alameda, and Contra Costa Counties, coal signs having been reported one time and another in almost every county in the State. A table of approximate analyses of California lignites is given on page 14 of this report.

ELSEWHERE ON THE PACIFIC COAST—THE COOS BAY FIELD.

A coal-bearing territory of considerable extent skirts the easterly shores of Coos Bay, in the southwestern part of Oregon. A great deal of money was expended some ten or twelve years ago in opening up these mines, and in constructing railroads, wharves, and coal bunkers, for transporting their product to and receiving it at tide water, and in providing vessels for carrying it thence to San Francisco, where for several years the receipts of coal from that quarter were quite heavy. Latterly, however, and for reasons not generally understood by the public, they have been comparatively light. Again they appear to be on the eve of being increased, certain movements recently made, by the owners and others interested in these coal fields, indicating a purpose on their part to work them once more on a large scale. The Newport, formerly one of the active companies at

Coos Bay, and still large owners there, have contracted with the Union Iron Works, of San Francisco, for the construction of a large steel steamer, to run between that port and their coal mines. Another steamship, lately launched at Marshfield, on Coos Bay, has been brought to San Francisco to receive her machinery, built at the Fulton Iron Works. Being named the Coos Bay, this vessel is presumably intended for the trade between this city and that point. It would look as if these mines ought to be more largely worked than they have been of late, as they have been pretty well opened up, supplied with extensive plant, and lie convenient to navigable waters.

WASHINGTON TERRITORY.

In this Territory occur the most extensive and, at present, largely productive coal fields on the Pacific Coast. The output here will probably be greater this year than it was last, although the Seattle mines show for the first six months of the year a decline that is not made up by some slight increase at Carbon Hill. It is anticipated, however, that the output at both these places will be larger for the last half of the year than it was during the first half. Owing to a fire that occurred in the Bellingham Bay mines several years ago, destroying the plant and underground works, they have not been worked since, though known to contain a large body of good coal. These mines are situated in the extreme northern part of the Territory, close to the British Columbia line, and on the westerly verge of an extended coal field.

The Seattle coal is a lignite from the Newcastle and the Renton mines, the former located twenty and the latter thirteen miles easterly from the town of Seattle on Puget Sound; this coal taking the name of the town for the reason that it is shipped at that port. Both of these mines are connected with Seattle by rail, a wharf having capacity to put 2,000 tons of coal per day on shipboard having been built at that place. The owners of these mines have provided a large fleet of steam and sail vessels for carrying their product to San Francisco where they have capacious depots for receiving and storing coal.

The Carbon Hill mines are situated on Carbon River, 32½ miles northeast of Tacoma, on Puget Sound, where this coal is shipped and therefore often called Tacoma coal. These mines belong to the Pacific Improvement Company, who have a line of powerful steam colliers for transporting their product to San Francisco Bay, where extensive bunkers have been built, and whence it is distributed as required by the locomotives and steamers of the Central Pacific and the Southern Pacific Railroads, which consume the most of it. There are three veins being worked at Carbon Hill, one having a thickness of 17½ feet, one of 6, and one of 4½ feet. They are worked through a tunnel above the level of which there is estimated to be a very large quantity of coal. This has been pronounced by experts a good bituminous coal, hard and clean and superior to any found elsewhere on the coast, though not equal in heating capacity to the best Pittsburg. It is also claimed that this coal can be coked to advantage. About 250 men are employed at these mines on wages varying from $2 75 to $3 per day, boarding themselves. Some work by the piece, receiving from $2 to $3 per cubic yard broken out. At the Seattle mines about an equal number of men are employed and on similar terms, the prices paid workmen in the California coal mines being a little less than in those of Washington Territory.

OTHER COAL FIELDS WEST OF THE ROCKIES.

In Arizona, Utah, British Columbia, and Alaska, coal is known to exist, the quantity in some of these countries being large. The British Columbia mines, which are quite extensive, contribute largely towards supplying the wants of California, the best coal yet obtained on the coast coming from these mines. Judging from the small lots from that country that have come to hand, Alaska also affords some excellent coal.

Several years ago the Central Pacific Railroad Company, who own extensive deposits of coal in Wyoming Territory, having opened them up at much expense, made a determined and somewhat costly effort to employ the product of these mines for their own use, and also introduce it on the San Francisco market. Though an excellent coal for many purposes, railroad transportation for more than a thousand miles proved too expensive to warrant a continuance of the effort. As a result, there has been received at San Francisco during the past twelve years or more very little of the so called Rocky Mountain coal, though the above company have all the while used some of it on the eastern portion of their road, and will continue to do so, increasing, very likely, the quantity consumed in the future.

According to late reports, an extensive coal field has been discovered in the northeastern part of Arizona. Samples brought from that quarter show this to be a good quality of coal, and the find will be of great importance should the deposits prove to be large and permanent.

A SIMPLE METHOD FOR TESTING THE QUALITY OF COAL.

The following is the substance of a paper prepared by Melville Attwood, describing simple and effective means devised by him for determining the different varieties of coal, this paper having been read by the author before the California Academy of Sciences, June 2, 1884. The method of procedure in making these tests, as described by Mr. Attwood, is as follows: Having procured a streak plate of hard porcelain, work a smooth even surface upon it with a fine emery file, using water with a little washing ammonia in it. This done, paste letters on the margin of the plate to designate the different samples of coal to be tested. Select a piece of coal free from decomposition, earthy or other extraneous matter, and, rubbing it gently on the plate, compare the streak made with the known varieties, the plate being so moved that the rays of light will fall on the streak from different directions. To facilitate the process of rubbing, it may be performed through small slots cut in a piece of cardboard laid on the plate. By the above means the character of a coal can, in Mr. Attwood's opinion, be determined with considerable accuracy, the better varieties giving a blackish, while the inferior give a brownish streak. The former contain but a small amount of combined water, while the latter contain it in excess.

Remarking further on the examination of different kinds of coal, Mr. Attwood quotes from Crooke's Metallurgy to the effect that the nature of this fuel can often be judged of by its external appearance; a full black color, lively luster, and great hardness, indicating the presence of much oxygen, while a pitch-like luster shows a small, and a glassy luster a somewhat larger amount of carbon. A black color, strong luster, slight coherence, and little tenacity, denote a large amount of carbon with more hydrogen than oxygen. A brownish black color, dull appearance, strong coherence, and a certain hardness, show little carbon with more oxygen than hydrogen. The entire paper will be published in the proceedings of the society.

The wasteful consumption of coal in open grates and under boilers, is the subject of an article in one of the scientific journals, in which Mr. Weldon, a well known English chemist, is quoted as saying that it is difficult to insure the complete combustion of coal, even in making a chemical analysis, and in the open grate it is impossible. By dry distillation, he says, a ton of coal can be made to yield twenty pounds of ammonium sulphate, worth eighty cents, and the soot that lodges in the chimneys and defiles furniture and buildings, would yield coal tar. As a remedy for all the waste and the difficulties involved, Mr. Weldon asserts that coal should be distilled in close vessels, and all the products of distillation be collected. This being done, the gas would serve to distill fresh coal, and to work gas engines to generate electricity for light, the ammonia would be a superior fertilizer for land, the tar would be manufactured into dyes, the residuum of coke being employed for heating purposes, etc.

The approximate analysis of coal which serves all practical purposes, is made as follows:

A portion of 100 parts is pulverized and dried at a water bath heat, until it ceases to lose weight, the loss equals the percentage of water.

A second portion of 100 parts is pulverized and heated to redness in a shallow vessel exposed to the air, until a perfect ash only remains—the residue equals the percentage of ash.

A third portion, also 100 parts, in small lumps, is heated to redness in a closed vessel (a platinum crucible, with cover, is the best), until no more inflammable gases escape. The crucible must be cooled without removing the cover. This operation divides the coal into two portions, fixed and volatile; one can be weighed, and the other cannot. Subtract the weight of the coke from 100, and the loss will equal the volatile portion, including water. Example: Suppose the water to be 10 per cent; ash, 5 per cent; coke, 47 per cent. Subtract the coke (47) from 100, and the difference (53) is the volatile portion; from the coke subtract the ash, and from the volatile portion the water. The results, in percentage, will be as follows:

Fixed carbon	42
Volatile combustible matter	43
Ash	5
Water	10
	100

The gas may be conveyed into an inverted bell-glass in a pneumatic trough, and measured, if so desired.

Ionite is a hydro-carbon mineral, first described by Samuel Purnell, in the *Mining and Scientific Press* of March 24, 1877. It was first found in Ione Valley, Amador County, whence the name. The following are extracts from Mr. Purnell's description: When first found it contains 50 per cent of water, but when air dried it floats on water, the specific gravity being about .9—melts to a pitch-like mass which burns easily with a dense black smoke, having a resinous aromatic odor and with a yellow flame.

Ionite contains 13 per cent of impurity, principally silica and alumina. Streak reddish yellow, fracture irregular, luster none, when pulverized water suspends a portion of the clay in the mineral. It is partly soluble in cold alcohol, more so in boiling alcohol, giving a brown solution. On addition of water no precipitate is deposited, but the solution becomes permanently of a milky color. Very soluble in ether, forming a brownish black solution; on adding water a brown tarry substance is obtained, very inflammable, and which, while burning, gives off the odor of burning sealing wax, wholly soluble in chloroform, except the clay or ash, forming a brownish black solution; poured into water a brown oil falls to the bottom, partly soluble in cold, more so in boiling oil of turpentine, forming a wine-red solution; on concentration of the solution crystals of paraffine are separated, almost wholly insoluble in cold or boiling petroleum naphtha; subjected to dry distillation a brown tarry oil passes over mixed with green colored water.

Ionite is found in considerable abundance at the original locality, and I have found it in lignite beds in San Benito County. It will be more carefully studied in the future and will perhaps be found valuable otherwise than as a fuel.

99. MINERAL WATERS.

Springs of mineral water are quite abundant in California. The State Mining Bureau has information concerning fifty-eight springs, all of which have more or less notoriety. Nothing reliable can be given concerning them beyond what was published by Dr. F. W. Hatch.

Allusion has been made elsewhere in this report to certain minerals which exist in mineral waters, and to the importance of careful analyses and the publication of an official guide-book. This the Mining Bureau will endeavor to accomplish, if it has the needed support and means to establish the required laboratory. Samples of water from the greater lakes of the State have been obtained and placed in the State Museum preparatory to analysis.

Mispickel—see Arsenopyrite.

100. MOLYBDENITE. Etym. *Lead* (Greek). Sulphide of Molybdenum.

This is a soft, black, lustrous, foliated mineral, resembling graphite, for which it is frequently mistaken. It has no special value. It is rather common in California, in the granites of the Sierra Nevada, and associated with gold in the quartz veins, and frequently with copper and silver ores. According to Dana, it is found with molybdite and gold in the Excelsior mine, Nevada County. The State Museum contains several specimens. No. 4126 is from Speckerman's mine, six miles above Fresno Flat, Fresno County; No. 3748 from the Beveridge mine, Inyo County (this is foliated and was mistaken for graphite); No. 4102 from the White Mountains, Inyo County; No. 4365 from near Independence, Inyo County; No. 4454 from South Fork of King's River, fifty-five miles northeast of Visalia. It has also been met with in the Cosumnes copper mine, El Dorado County.

101. MOLYBDITE. Molybdic Acid, Molybdic Ochre.

According to Dana, this mineral is found in the Excelsior mine, Nevada County, with molybdenite and gold.

MOUNTAIN BLUE—see Azurite.

MOUNTAIN BUTTER—see Lenzinite.

MOUNTAIN CORK—see Amphibole.

MOUNTAIN LEATHER—see Amphibole.

MUNDIC—see Pyrite.

MUSCOVITE—see Mica.

NATRON—see Trona.

102. NICKEL. See also Millerite and Zaratite.

Nickel is rather a rare metal, and is generally found associated with iron and cobalt; the same association occurs in meteorites. It is never found in the metallic state (except in meteorites), being always combined with other elements, as arsenic, sulphur, oxygen, silicon, copper, antimony, carbon, etc., as well as with iron and cobalt.

It is a silver-white, malleable, and ductile metal; sp. gr. 8.28 when cast, and 8.666 when forged.

It possesses the power of attracting the magnet, like iron; it is less fusible than iron, and does not easily oxidize, for which reason it is extensively used for plating iron and other metals likely to tarnish by exposure to air and moisture. It is also used in alloys, the most useful being German silver, composed of copper 100 parts, zinc 60 parts, and nickel 40 parts, fused together. It is also used for coin; the United States five-cent nickel coin being: copper, 75 per cent; nickel, 25 per cent; weight, 77.16 grains. The three-cent nickel coin has the same composition, weight 30 grains.

Nickel was first discovered in 1751 by Cronstedt, in a mineral called by the miners "Copper nickel" (Kupfernickel), or false copper, because although it had the appearance of being copper ore, it did not contain that metal. Kupfernickel is now called Niccolite, and is composed of nickel and arsenic. The test for nickel, even by an expert chemist, is attended with difficulties, and there is no simple, easy, characteristic test by which the prospector can identify it. The principal ores of nickel are niccolite; pale copper color, streak brownish red, brittle. When heated on charcoal, it gives off fumes of arsenic, recognized by the smell of garlic. Millerite; brass-yellow resembling chalcopyrite, gives a reaction of sulphur, but no copper. Genthite, or Garnierite; apple green in color. Silicates and arseniates of nickel have been found in Oregon and Nevada, and are likely to be found in California. Millerite and Zaratite are the only nickel minerals as yet discovered in the State, and these only in very small quantities. Dr. Trask in his first "Report on the Geology of the Coast Mountains, and part of the Sierra Nevada, 1854," refers to nickel ores, "in the coast mountains from Contra Costa to the utmost limit reached in that range, associated with chromic iron in primitive rocks. The mineral is more abundant in the serpentine rocks south of Tularcitos, and near San Antonio, Monterey County. This mineral, Zaratite, or "Emerald Nickel," will be described under the proper head.

Nitrate of Soda—see Soda, Niter.

Obsidian—see Orthoclase.

Ochre—see Limonite.

Onyx Marble—see Aragonite.

103. OPAL. Etym. *Opalus* (Latin). Hyalite, Wood Opal.

Opal has the same chemical composition as quartz. Silica is demorphous, opal assuming one form and quartz the other. Opal is softer and of less specific gravity, and is never found crystallized. It is generally soluble in a hot solution of caustic potash, and usually contains water. The precious opal is very valuable, but is rare; it has never been found in California. In May, 1883, when the mineral collections of Honduras were exhibited in the State Museum, magnificent opals were included, some of which were the largest and finest ever known. Common opal has been found in several localities in the State.

A white, milky variety of opal is found in Calaveras County, at Mokelumne Hill, or on the hill near that place known as Stockton Hill, on the west side of Chile Gulch. A shaft has been sunk there three hundred and forty-five feet, and the opals are found in a thin stratum of red gravel. They vary in size from a kernel of corn to the size of walnuts. Many of them contain dendritic infiltrations of manganese oxide, looking like moss. About a bushel of these stones are raised in one day, and are said to have a market value. A white, milky variety similar to the above, and without "fire," is found with magnesite in the Mount Diablo range, thirty miles south of the mountain. Also in the foothills of the Sierra Nevada, at the Four Creeks (Blake).

This locality is represented in the State Museum by No. 4395. They are also found near Murphy's, Calaveras County (Dana), and in Plumas County (Edman). Hyalite is found at Volcano, Amador County (Dana). Associated with semi-opal in the Mount Diablo Range, about 30 miles south of Mount Diablo (Blake). Also, 9 miles northeast of Georgetown, El Dorado County. No. 1347 in the State Museum is from Kelseyville, Lake County; and No. 1514 is found plentifully in cavities in basaltic lava, Township 10 north, and Ranges 5 and 6 east, Lake County. Hyalite resembles glass, and is generally found in irregular fragments. Opalized wood is wood petrified and changed to opal. It is not uncommon in the hydraulic gold mines, in magnificent specimens.

Opalized Wood—see Opal.

104. ORTHOCLASE—see also Feldspar—Common Feldspar, Potash Feldspar.

This mineral derives its name from the Greek, meaning "*straight break,*" because it cleaves at right angles. It is a silicate of alumina and potash.

Silica	64.6
Alumina	18.5
Potash	16.9
	100.00

Many rocks contain orthoclase as one of their constituents. Granite and gneiss are composed of orthoclase, mica, and quartz. Granulyte, Pyroxenite, Orthoclase felsite, some varieties of Porphyry, Phonolyte, Trachyte, Obsidian, Halleflinta, and Pitchstone, contain orthoclase.

Orthoclase readily decomposes and forms soils. It is used as a source of potash; and with kaolin and quartz, in the manufacture of porcelain and pottery. Obsidian, a variety of orthoclase in an impure state, is a lava cooled quickly. The obsidians vary in composition; to all appearance they seem homogeneous, like glass, but if examined microscopically they are found to be full of minute and sometimes very beautiful crystals. Obsidian was known to the ancients, and was used for stone implements in the most remote ages, long before the commencement of history. It has the property of breaking evenly into fragments with sharp edges. The Aztecs used knives of obsidian in their human sacrifices. The word obsidian (obsidianus lapis) is said to be derived from Obsius, a Roman who first brought it from Ethiopia. According to Pliny, it was called also Liparæn, from the island of Lipari, which produced it. It was used by the Romans for mirrors placed in walls. The inhabitants of Quito, not many years ago, made the same use of it.

When first discovered, years ago, at Clear Lake, in Lake County, a company was formed to make bottles and other glassware from it, but the enterprise was of course a failure. Orthoclase is found in numerous localities in California. "In San Diego County, in granitic veins along the road between Santa Isabel and San Pasquale, associated with tourmalines and garnet; in Fresno County, at Fort Miller, in coarse-grained granite, under the edge of the lava plateau" (Blake); at Meadow Valley, Plumas County (Edman). Nos. 438 and 445, in the State Museum, are from the Yosemite Valley, Mariposa County, occurring in veins in granite with molybdenite; said to exist in veins several feet thick at Tehachipi Pass, Kern County. Obsidian is found near Lower Lake, Lake County; very fine specimens—black, gray, red, and variegated. No. 4908, State Museum, is from McBride's ranch, Mono County, and No. 4674 from near the south end of Goose Lake, Modoc County. It is also found near Mono Lake, Mono County; three miles north of Napa, Napa County; and in Inyo County, with basaltic lava. Some varieties of obsidian cut beautifully, and might be used for ornamental purposes, for paper weights, vases, bases of clocks, and similar purposes.

Osmium—see Iridium, with which it is invariably alloyed or associated.

Pandermite—see Priceite.

Partzite—see Stibiconite.

Pearl Spar—see Dolomite.

105. PECTOLITE. A single specimen was found in a bowlder or fragment at the foot of the White Mountains, near Montgomery, Mono County. Doubtful (Aaron).

106. PETROLEUM.

ITS DIFFERENT FORMS AND THE VARIOUS NAMES APPLIED TO THIS SUBSTANCE.

The term petroleum, derived from the Latin words *petra*, a rock, and *oleum*, oil, is applied to mineral oils, of whatever nature they may be, from the tar-like substance changed by inspissation into asphaltum, to the water-white liquid resulting from the distillation of the crude oils. The more liquid varieties are called naphtha; the more viscid and dark colored, mineral tar or maltha.

In this paper, asphaltum, bitumen, idrialite, and aragotite, as well as petroleum, will all be considered, as they possess many properties in common, and have probably a common origin. Petroleum is known under the several names: rock oil, mineral tar, maltha, naphtha, Seneca oil, Genesee oil, paraffine, coal oil, benzine, kerosene, benzol, british oil, gasoline, rhigoline, Barbadoes tar, etc. Asphaltum is also variously called bitumen, jews' pitch, mineral pitch, brea, etc.

WHAT THE ANCIENTS KNEW ABOUT IT.

While the existence of petroleum has been known from the earliest historic times, its extensive use for economic purposes, and its application in the arts, are of comparatively modern date. Pliny, book 2, chap. 108–9–10, makes mention of maltha and naphtha, like petroleum, liquid forms of asphalt or bitumen. Plutarch describes a lake of *inflamed naphtha*, located near Ecbatana, the modern Hamadau, a city of central Persia. It is highly probable that the fires kept perpetually burning in pagan shrines consisted of natural gas jets, or were fed with petroleum.

The following is quoted from Herodotus (Melpomene, 195):

They add that in it (the Island of Cyraunis) is a lake from the mud of which the virgins of the country draw up gold dust by means of feathers. Whether this is true, I know not, but I write what is related. It may be, however: for I have myself seen pitch drawn out of a lake and from water in Zacynthus (now Zante), and there are several lakes there. The length of them is seventy feet each way, and two orgyæ in depth. Into this they let down a pole with a myrtle branch fastened to the end, and then draw up pitch adhering to the myrtle. It has the smell of asphalt, but is in other respects better than the pitch of Pieria. They pour it into a cistern dug near the lake, and when they have collected a sufficient quantity, they turn it off from the cistern into jars.

As the foregoing was written more than two thousand years ago, and these springs near Zante still continue productive, the permanent nature of this class of deposits is, at least in the present instance, pretty well established.

Strabo, book 16, chap. 1–15, says that *asphaltus* is found in great abundance in Babylonia, and quotes Eratosthenes as follows:

The liquid asphaltus, which is called naphtha, is found in Susiana; the dry kind, which can be made solid, in Babylonia. There is a spring of it near the Euphrates. When this river overflows at the time of the melting of the snows, the spring also of asphaltus is filled and overflows into the river, where large clods are consolidated, fit for buildings constructed of baked bricks. Others say that the liquid kind also is found in Babylonia. With respect to the solid kind, I have described its great utility in the construction of buildings. They say that boats (of reeds) are woven (Herod. i, 194), which, when besmeared with asphaltum, are firmly compacted. The liquid kind, called naphtha, is of a singular nature. When it is brought near the fire, the fire catches it; and if a body smeared over with it is brought near the fire, it burns with a flame which it is impossible to extinguish, except with a large quantity of water; with a small quantity, it burns more violently; but it may be smothered and extinguished by mud, vinegar, alum, and glue. It is said that Alexander, as an experiment, ordered naphtha to be poured over a boy in a bath, and a lamp to be brought near his body. The boy became enveloped in flames, and would have perished if the bystanders had not mastered the fire by pouring upon him a great quantity of water, and thus saved his life.

Poseidomus says that there are springs of naphtha in Babylonia, some of which produce black, others white naphtha; the second of these, I mean the white naphtha, which attracts flame, is liquid sulphur; the first, or black naphtha, is liquid asphaltus, and is burnt in lamps instead of oil.

PRESENT PRODUCT OF THE OLD WELLS.

Many of the petroleum springs known to the ancients have been extensively worked in recent times. From those near Baku, a Russian port on the west coast of the Caspian Sea, considerable quantities of naphtha are annually exported. Here great quantities of inflammable gas also issue from the ground. This locality was in former days visited by thousands of Guebers, or fire worshipers, who built temples on the spot in which to conduct their religious ceremonies. They are still frequented by the devotees of this faith, many of whom spend here the remnant of their days engaged in acts of devotion. James Parkerson, author of "Organic Remains of a Former World," published in the early part of the present century, shows by quotations from "Abbé Forti's Travels," in Dalmatia, and the works of Captain Cox, that no less than 26,000,000 gallons of petroleum were, even at that early period, shipped annually from this port. This oil is exported largely to Persia, in portions of which it is the only material used for producing artificial light. These Baku deposits occur over a tract 25 miles long by half a mile in width. The oil here is gathered in wells sunk from 16 to 20 feet in the porous sandstone. That obtained near the center of the tract is quite clear, but the material grows thicker and darker as the edge of the deposit is approached, until it finally hardens into asphaltum.

From the Rangoon district, in India, a large portion of that country and the whole of the Burman Empire are supplied with rock oil, which occurs here, and is collected in much the same manner as above described. As at Baku, these Rangoon wells have been yielding since the earliest times.

KEROSENE AND COAL OIL.

Although the attention of the Royal Society of London was as early as 1739, called to the fact that in making gas from coal, a black oil was left as a by-product, no practical results came of it, and it was left for the French to first distil coal oil from bituminous shales. In 1847, Dr. Abraham Gesner obtained from Trinidad, asphaltum oil and naphtha. This oil he burned in lamps during a lecture given by him in Halifax. He had the year before commenced making oil from Prince Edward Island coal. The first patent for distilling oil from coal was, however, granted to the Earl of Dundonald, in 1781. In 1850, James Young, a chemist, of Manchester, England, patented a process for obtaining paraffine oil from coal, and four years later began manufacturing it largely.

In 1854, Dr. Gesner procured a patent for making kerosene oil, an article so named from the two Greek words *Keros*, wax, and *Elain*, oil. Camphene being at the time a well known burning fluid, this word was added to *Keros*, and from the new term the word *Kerosene* was formed. The first mineral oil manufactured in the United States was made by Dr. Gesner, in 1854, at the works of the New York Kerosene Oil Company, on Long Island.

The production of coal oil was at one time quite large in the United States, there having been no less than fifty-six works engaged in its manufacture. The following was the method pursued in making it: A quantity of the crude oil, having been distilled off roughly, was submitted to fractional distillation, after which the product was treated by sulphuric acid, whereby the dark maltha was thrown down, the acid was then neutralized by excess of caustic soda, and the clean portion thoroughly washed with water, to remove both the acid and alkali. The fluids were then either sold as they were or again distilled, this depending on the quality required. The production of coal oil, though discontinued in the United States, is still carried on in some other countries, there being no less than sixteen companies engaged in the distillation of coal oil from shale in Scotland. Where practicable, the business is deserving of encouragement, both as a means of utilizing what in many localities is a cheap and abundant material, and of economizing our petroleum resources, which we are exhausting at a rapid and in some instances reckless rate.

A ton of Virginia cannel coal yields products as follows:

Kerosene	25 gallons.
Lubricating oil	10 gallons.
Naphtha	10 gallons.
Paraffine	10 pounds.
Ammonia	10 pounds.
Carbolic acid	10 pounds.

And usually from 1,000 to 1,200 pounds of coke.

The time will very likely come when coal, petroleum, asphaltum, and the bituminous shales will be retorted into gas and coke; the former to be employed for both heating and illuminating purposes and driving gas engines, and the latter as a clean and economic fuel, being used, perhaps, under the very retorts by which it is produced.

EARLY HISTORY OF PETROLEUM IN THE UNITED STATES—FIRST BORINGS AND RESULTS.

The Indians inhabiting portions of southern New York and central Pennsylvania had a knowledge of the petroleum springs that exist in that region, and were in the habit of using the crude oil as a liniment long before the country was settled by the whites. At a later day the Indians, collecting this substance, sold it to the settlers, under the name of Seneca or Genesee oil.

As early as 1847 James Young, the Manchester chemist before mentioned, experimenting on a shaly coal taken from a mine in Derbyshire, succeeded in obtaining therefrom an excellent lubricating oil. The success of this experiment laid the foundation of the business of refining and preparing the crude mineral oils, which has since grown to such vast proportions in this country.

In 1857 Bowditch & Drake, of New Haven, Connecticut, commenced the business of searching for oil, which they proposed to refine and sell.

In 1858–9 Col. E. L. Drake commenced boring in the bed of Oil Creek, Pennsylvania, where, on the twenty-sixth of August, 1859, he struck oil at a depth of 71 feet. This oil rose in the pipe to near the surface, and by pumping 400 gallons per day were obtained, which quantity was finally increased to 1,000 gallons. Encouraged by this success, many other parties at once commenced boring, and so rapidly were these efforts multiplied, that there had within a year been sunk in this section of the State no less than 2,000 wells, 74 of which yielded daily enough oil to fill 1,165 barrels, of the capacity of 40 gallons each—46,600 gallons.

Following the grand results so reached in Pennsylvania, the business of boring for or otherwise searching after coal oil was actively engaged in throughout many parts of the world; deposits already known to be productive having in many cases been more fully utilized, while new ones were diligently sought after. While these efforts were in most cases attended with disappointment or only a partial success, they have, nevertheless, led to many important discoveries and a great expansion of the known oil-bearing territory of the world.

ORIGIN OF PETROLEUM.

It must be admitted that the origin of petroleum and the mineral hydro-carbons is unknown. New theories are continually being published bearing on this subject. For many years it would have been a geological heresy to deny that beds of coal were formed during the carboniferous age from vast accumulations of trunks of tropical trees, and other vegetable matter. When enormous petroleum deposits in the United States and other countries were discovered, this came to be doubted, and it began to be suspected that both coal and petroleum had a common origin. The opinion obtained that petroleum was first formed, and afterwards changed into coal, asphaltum, and other bituminous substances, while some believed that petroleum resulted from coal. Oil had already been distilled from coal and called coal oil. Opinion was divided, some thinking that petroleum was the result of some change from coal, as obtained from artificial distillation, while others held that petroleum might have been the original form and that coal was secondary. Among the numerous theories advanced on this subject the most important ones only will be mentioned. The generally admitted theory of the origin of coal has been mentioned. Prof. T. Sterry Hunt thinks petroleum was derived from limestones, rich in marine corals. In the Report of Geological Survey of Canada, from commencement to 1863, folio 521, it will be found stated that in the birdseye formation at the Rivière à la Rose, Montmorenci, petroleum exudes in drops from fossil corals. J. P. Lesley and others have thought that petroleum has been derived from the decomposition of great accumulations of seaweed at the bottom of ancient seas, covered with sediments so heavy that the pressure caused by their weight was an important factor in the change. An examination of the sedimentary rocks exposed in Pico Cañon and at Los Angeles would lead to the opinion that some similar cause produced petroleum in California. Professor Whitney has suggested that the infusoria and diatomacea, the remains of which are so abundant in the State, may have produced the petroleum. Professor J. S. Newberry refers the petroleum and carbonaceous matter in the shales of Pennsylvania to the cellular tissue, which was abundant in the waters in which the sediments were formed.

Those who have frequently crossed the Gulf Stream and observed the vast quantities of floating seaweed, would be free to admit that not only possibly but probably the sedimentary beds now forming in the gulf, near the mouths of the Mississippi, might, when elevated above the sea level, at some future period, contain petroleum, and resemble the sedimentary rocks of the California seacoast before mentioned.

Another theory bearing on the organic origin of the bitumens is, that the bodies of mollusks, the shells of which are found fossil in the sedimentary rocks, contributed to the bituminous deposits of the present day.

It was, to be sure, a bold man who first proposed the theory that the elements carbon and hydrogen combining in the early life of the world, produced, directly or indirectly, petroleum and mineral coal. But geologists now dare to discuss these theories, and are willing to admit that the truth is not yet known.

Daubre and Bertholot have expressed the opinion that carbon and hydrogen may have united without the intervention of animal life at some period of the earth's history when conditions differing from those of the present time made this possible. Mr. A. Jaquith, in a very interesting paper in the *Overland Monthly*, December, 1874, vol. 13, folio 503, has expressed this opinion, or rather suggested this theory, and others have advanced the same idea, based upon observations made by them.

The following is an extract from a newspaper giving the substance of an article published in the *Revue Scientifique* in 1877, three years after the publication of Mr. Jaquith's paper:

THE ORIGIN OF PETROLEUM.

At a recent meeting of the Chemieal Society of St. Petersburg, Professor Mendelijeff sought to combat some of the old notions on the origin of petroleum, and to substitute a new theory on the subject. It has been maintained by many geologists that the decomposition of mineral matter in the lower strata of the earth was the source of petroleum.

Mendelijeff believes that the true source is to be found much lower down. The sandstone in which it is found was not its original source, as is shown from the fact that no carbonized animal remains are found in it. There ought also to be other products of animal decomposition, if that was the starting point; we must search lower down, even below the silurian, as the mineral oil in the Caucasus is found in the tertiary, and in Pennsylvania in the devonian and silurian. As, however, in the rocks below the silurian there was very little organic life, the formation of such a great quantity of petroleum could scarcely be traced to such a limited source. Mendelijeff therefore proposes a substitute for the organic theory. He goes back to the nebular hypothesis of Laplace, and applies Dalton's law of the original gaseous condition of the material of the earth, and, taking into consideration the density of the earth and the vapor density of the elements, he arrives at the conclusion that the interior contains many metals, and that chief among them is iron; finally, he assumes the presence of carburetic compounds of the metals, and comes to the following conclusions: Through some of the fissures in the crust of the earth, occasioned by the upheaval and depression of the surface, water percolated to the carburetted metals, and acted upon them at high temperature and elevated pressure, thus forming metallic oxides and saturated hydro-carbons; the latter rose in the form of vapor to the upper strata, where they condensed to liquids in porous sandstones and other rocks having a tendency to absorb liquids. The internal heat of the earth occasioned the reduetion of carburetted metals, and this gave rise to hydro-carbons. Other chemists than Mendelijeff have shown, experimentally, that something very like petroleum can be produced artificially by imitating in the laboratory the process above described.

The geological age of rocks seems to have no bearing on the origin of petroleum. It is found in the tertiary in California and elsewhere, silurian in Canada, and lias in England.

PROSPECTING FOR OIL.

The only satisfactory way to prospect for oil is to sink holes in the ground; the superficial method of making open cuts or tunnels in

California has never resulted in producing it in sufficient quantity, or of the desired quality. All the early failures were owing to this mistake, but they have led the way to an understanding of the nature of the deposits, and made it worth while to invest capital in the drilling of proper wells, and the experience made during the early developments, or rather experiments, while disastrous to individuals, has been a benefit to the State. The improved tools now used for sinking oil wells are so nearly perfect that improvement to any great extent seems impossible. The 65 foot derrick, the improved engine, the iron casing to prevent the surface water from entering, the magnificent tools weighing 2,000 pounds, or thereabout, the ingenious appliances for driving the casing, or drawing it out, if required, the sound pump, the seed bag, the dynamite blast, the system of tanks, and the device of pumping through pipes from the wells to any distant point, instead of hauling as formerly practiced, are the outgrowth of the experience made in the Pennsylvania oil fields. By the improved method of drilling, 70 feet in depth per day can be averaged, and prospectors can afford to sink a number of wells, if even one only produces oil. The old method first practiced in California, was known as the spring-pole system. The spring-pole acted like the old fashioned well-sweep, the derrick was 25 to 30 feet high, and the operation was conducted by two men. The depth attainable was from 300 to 400 feet. What is known as a spring-pole well is one sunk by this method; the diameter of the bore was generally two to two and one half inches, the modern well is eight inches at the surface, but diminishing with the depth. The favorable indications met with in sinking oil wells are the escape of gas, flow of salt water, and the appearance of oil in thin iridescent skims on the surface of the water pumped from the well. The borings are sometimes tested by being placed in a small retort, which, if put on the fire and strongly heated, a gas escapes from the end of the pipe, which may be ignited, or a drop of oil appears. This experiment is sometimes made in a common tobacco pipe.

CHEMISTRY AND ASSAY.

Petroleum seems to be a natural mechanical mixture of many hydro-carbons, each having a specific gravity, boiling point, and vapor density; proportion of the elements, from C_2 H_6 in gaseous form to C_{30} H_{62}; having a specific gravity of .890. These hydro-carbons are separated by fractional distillation, as follows: The crude oil is placed in a suitable retort, provided with an ample cooling apparatus (on a large scale this is described under Refinery). The whole volatile portion is driven over into the receiver. There is generally a residue left in the retort; the percentage is calculated, the retort cleaned, and the fluid returned to it. A gentle heat is then applied, and a certain portion—say a tenth of the whole—is distilled over; the distillate is poured off, or the receiver changed, the heat slightly raised, and a second tenth distilled off. This is continued until ten portions, each distilled at a higher temperature, have been obtained; or a thermometer is placed in the retort, and all the portion which comes off at a certain heat kept separate from that obtained at a different temperature. The works on chemistry give tables of the temperature at which each of the many hydro-carbons volatilize. By care in manipulation any one of the group may be obtained. Asphaltum and the bitumens contain oxygen. The hydro-carbons are grouped by Dana as follows: Simple hydro-carbons, oxygenated hydro-carbons, acid hydro-carbons, hydro-carbon compounds; which latter include asphaltum, and mineral coal, and unclassified species. The chemistry of the hydro-carbons is extremely complex, and it would be out of place to elaborate upon it here. A list of books of reference is given, to which the reader is referred.

Burning oils are tested by the following method: No petroleum or coal oil is safe to use that can be lighted with a match. To make this test, pour out a very small quantity, say a tablespoonful, into a saucer; remove the can to a safe distance, and then, with a lighted match, attempt to light the oil in the saucer. If the oil is safe, it will quench the flame like water. If the test is repeated for a number of times, the oil will become hot and will ignite. If it does not ignite the first time, it may be considered comparatively safe. If it should ignite, it is dangerous and should never be used for illuminating purposes.

When coal oils are gradually heated, a point of temperature will be reached when they will give off vapor; at this time, if a lighted match is applied to the surface, a slight flash will occur, but the oil itself will not inflame. If the heat is increased sufficiently, the oil will burn on applying the match. A thermometer, the bulb of which is immersed in the oil, will indicate the temperature at which the oil will flash or burn. This is what is known as the fire test. If an oil is too heavy, it will not burn well in lamps; if too light it is dangerous to use. An oil is considered safe that flashes at 100° Fahrenheit or higher, and burns from 110° to 150°. The report of Professor Chandler on this important subject, with drawings of the apparatus used in testing oils, may be found in the *American Chemist*, for August, 1872.

USES.

Petroleum and asphaltum are extensively used as fuel, and this application is daily becoming more general. Many improvements have been made in coal oil domestic cooking stoves.

Mr. J. D. Bodwell, of San Francisco, has applied it to heating large French ranges. A tank of crude petroleum, said to be *mixed with water*, is placed at some distance, which is connected with the range by a quarter-inch iron pipe, furnished with globe valve for shutting off and on. The fluid escapes into the fire chamber in a small jet, which impinges on loose fire-brick. I have seen the apparatus in operation in Eddy Street, and it worked well and was effective. The Electric Light Company, of Los Angeles, uses four to five carloads of crude Pico Cañon petroleum per month for fuel. Their apparatus is the same as that described under the head of "Refineries." Petroleum is used for burning lime at Colton, and experiments have been made, with partial success, in burning brick. The following is from a California newspaper, published January, 1879, alluding to the oil well at Little Sespe, Los Angeles County:

With this mineral oil in such abundance, it would probably soon supersede coal and wood as a steam generating fuel. Captain Roberts, Superintendent of the Los Angeles company, using it successfully in the furnaces at the well. Four barrels of crude oil go as far as two and a half cords of good live oak wood. This oil the company can, and, in fact, proposes to furnish in any quantity at one dollar per barrel. The gas companies of the larger cities will also, it is thought, substitute petroleum for coal, as there is more gas in a barrel of this substance than in a ton of coal. Schooners can be so constructed as to carry oil in tanks, which may be filled from pipes on the wharf, or it can be carried cheaply as ballast. After the burning fluid comes the lubricating oil, which is graded from the finest used on sewing machines, etc., down to car axles and wagons. It is in use on the Central Pacific road, and the "Star Oil Company" is supplying some large establishments in San Francisco. The refuse is used for fuel.

Brea (crude asphaltum) is used in California with considerable success, notably by Lankersheim & Co., at the Los Angeles flour mills, in wide grate bars with wood. Mr. Joseph D. Lynch, editor of the *Los Angeles Herald*, has used brea with wood in stoves to his satisfaction. The following is from an eastern paper:

PETROLEUM AS FUEL FOR THE RUSSIAN BLACK SEA FLEET.

It is well known that for some years the boilers of the Russian vessels in the Caspian Sea have been constructed for the consumption of naphtha refuse. Since the opening of the Baku, Tiflis and Batoum Railway the transport of this material to the coast of the Black Sea has been greatly facilitated and reduced in cost. It has, therefore, been decided to use it as fuel for the Black Sea fleet, and great advantages, both in effectiveness and cheapness, are expected to be secured. It is stated that the refuse can be delivered at Batoum at a cost of one shilling and seven pence per hundred weight, and as its heating power, compared with that of the best steam coal, is as three to one, the advantage of its employment is obvious. During the present season trials of this fuel will be made on several torpedo boats, for which class of vessels it is considered especially suitable. The necessary alterations in the furnaces, etc., will be made by Messrs. Nobel & Co., who have large petroleum refineries in Baku, and have already altered several of their own steamers with a similar object.

The Standard Hydro-Carbon Fuel Company of Boston claim to melt iron and copper, and reduce gold, silver, and zinc ores by their process. I have myself seen in San Francisco ores perfectly roasted by simply dropping through a cylinder heated by petroleum blown in with a jet of steam.

As a paint.—In 1867 a barn was painted with crude petroleum mixed with Ohio so called fire proof paint. After six years it was found to be well preserved.

In fireworks and war.—The Greek fire of the ancients is supposed to have been largely naphtha or crude petroleum with niter and sulphur. During the Commune in Paris in 1872, petroleum was largely used, both offensively and for defense. Its uses as an agent in war will probably be increased, as it becomes more abundant and attainable.

As a *lubricator*, the heavy mineral oils are extensively used.

ASPHALTUM—THE USES MADE OF IT IN EARLY TIMES.

Asphaltum was first found on the shores of the Dead Sea, which, for this reason, was called Lake Asphaltus. It was employed by the ancients for various purposes, having been used in the construction of buildings and the walls of cities, and by the Egyptians in embalming the dead. It is recorded that Noah covered the inner and the outer surfaces of the ark with pitch—bitumen, or asphaltum, no doubt. Herodotus relates that in laying up the bricks of which Babylon was built, hot asphaltum was used as a cement. The material was brought from the city of Is, located on a small river of the same name, a tributary of the Euphrates. This river, it is stated, brings down lumps of asphaltum floating on the water, this being the source whence the builders of Babylon obtained their supply. Strabo, Book XVI, Chapter 2–42, in speaking of Lake Sirbonis (the Dead Sea), says that asphaltus rises to the surface in bubbles, which emit an insensible, sooty vapor, that tarnishes silver, copper, and even gold. This substance is liquified by heat, but on cooling becomes so hard that considerable force is required to break it to pieces. In gathering it, parties go out on the water on rafts. In another place, the same author remarks that this material is abundant in Babylonia. Eratosthenes, speaking on the same subject, says the liquid asphaltus, called naphtha, is found in Susiana, and the dry kind, which can be made solid, in Babylonia, the latter being of great utility in building. Diodorus also makes mention of the Asphaltus Lake, on the surface of which he says the asphaltum rises at certain seasons of the year in masses, some of which cover an area as much as three acres in extent. In gathering it, the workmen went out on rafts built of reeds; just as the California Indians were in the habit of crossing rivers on similar structures made of tules.

Not in many countries, comparatively speaking, has asphaltum been found in large quantity, California being one of the few, and the only portion of the United States, in which it so occurs. Among foreign localities, a very remarkable deposit of this mineral exists in the Island of Trinidad, one of the British West Indies, and which is described as follows by U. S. Consul Towler, who recently visited it: To call this deposit a lake, as is usually done, is, according to the above authority, a misnomer, as it consists merely of a concrete, slightly flexible mass of pitch, spread out over a plain, some portions of it being covered with bushes and others with pools of water, and over which, but for these obstructions, a person can walk without difficulty. The deposit is distant one and a half miles from the seashore, above which it is elevated about 140 feet. The asphaltum is broken out with picks and carted to the port of La Bréa, where it is shipped to foreign countries. Only a foot or two of the surface is removed, the pitch below this becoming soft and plastic. The excavations made fill again in a short time with the fluid material from below, the new deposits hardening very soon into asphaltum. How long this reproducing process can be continued is uncertain, though it will no doubt, with lapse of time, grow more feeble, and, perhaps, ultimately be arrested altogether. Nevertheless, the visible supply here is large and will last a long time, the surface to a depth of one foot being estimated to contain 116,678 tons of asphaltum.

There exist several heavy deposits of asphaltum in California, this mineral, both natural and manufactured, being well represented in the State Museum. The earliest official mention of its existence is made by Dr. J. B. Trask, who, in his report of 1854, folio 59, speaking of the occurrence of asphaltum and mineral oil in the State, suggests their use in the manufacture of gas.

An analysis made of a sample of this mineral (5608), from the claim of Mr. A. Walrath, located near Santa Cruz, resulted as follows:

Asphalt	19.80
Sand	80.20
	100.00

Another sample, obtained from Santa Barbara County, gave:

Bitumen, volatile portion	35.0
Bitumen, fixed	7.2
Quartz sand	57.8
	100.0

The sand is angular, and consists nearly all of transparent quartz. The bitumen is soluble in turpentine. The above results denote very nearly the general character of California asphaltum.

WHERE FOUND IN CALIFORNIA.

The following comprise the more notable localities of asphaltum and maltha in this State: Santa Ynez and Kayamos Valleys; near Mission San Buenaventura; at the Goleta Landing, seven miles west from the town of Santa Barbara; on the Laguna Todos Santos and Los Alamos ranchos; in the vicinity of Dos Pueblos, and near Carpenteria, in Santa Barbara County; at the oil wells near Sulphur Mountain, Ventura County; Rancho La Bréa, Los Angeles County; on the Corral de Piedra, San Luis Obispo County; about Buena Vista Lake, Kern County, and on Sargent's ranch, Santa Clara County.

THE CARPENTERIA BED,

Situated three miles southeast of the town, though not spread over so large an area as some others, shows the heaviest surface accumulation of any deposit in the State. This bed, already large, is constantly being added to, the more volatile portions of the maltha and petroleum, which issue from innumerable fissures in the mass, escaping and leaving the heavier behind. This residuum hardens gradually, at first to the consistence of tar or putty, becoming finally so solid that picks and crowbars are required for breaking it out. The softer portions of this material, flowing off and gathering up the sand and gravel with which they come in contact, have been converted into a vast bed of concrete, some parts of which extend far out into the sea. The mineral oil at this locality exists under such varying conditions of fluidity and hardness, that it is possible to obtain here some pure petroleum, together with large quantities of asphaltum and maltha. Formerly a good deal of asphaltum was shipped from this deposit to San Francisco.

LA BREA RANCHO,

So named from the Spanish word "*bréa*," signifying pitch, lies about six miles west from the city of Los Angeles, being in Township 1 south, Range 14 west, San Bernardiño meridian. The deposits here, which cover a large area, consist mainly of bitumen and maltha, the latter occurring in the form of pools or wells. As at Carpenteria, the tar-like substance here flowing from numerous apertures becomes mixed up with such quantities of matter, both mineral and vegetable, that the whole mass has to be melted and the impurities separated from the asphalt to fit the latter for market. To effect this, the material is thrown into iron kettles and enough heat appplied to melt it, when the impurities floating on the surface are skimmed off, additional material being thrown in till the kettle is nearly filled with comparatively pure asphaltum, when the charge is poured out into trenches dug in the earth. On cooling, these pigs are broken up into smaller pieces, producing a commercial article of asphaltum. From this locality the Catholic fathers obtained asphaltum for roofing the missions and other buildings put up at Los Angeles, San Gabriel, and elsewhere in the vicinity.

AT SULPHUR MOUNTAIN

The solid asphaltum covers many acres to a depth varying from five to twenty feet. This bed, like that at Carpenteria, is undergoing constant enlargement, this process of growth being, in fact, characteristic of this class of mineral deposits in California, as it is probably of those in all other countries where they occur. Here, too, the petroleum, much of it quite pure, oozes from the fissures and vents seen all over the field. Flowing off, this more liquid portion becomes gradually thicker and thicker, until it is at last converted into tar, owing to the presence of which the locality has been rendered dangerous to animals, both wild and domestic, many of which, having become mired, have perished in the viscid mass. Even birds, alighting upon and getting their feet entangled in this stuff, have been unable to extricate themselves, as their bones and other remains amply attest. This tarry outflow, with its danger to animals, is another feature common to these *bréa* beds of California. The owners of stock in the neighborhood of these tar pools are in the habit of burning them out, as a means of diminishing the peril to which their cattle would otherwise be exposed. It only needs to start a fire, when the flames, sweeping over these pools, consume the more fluid portion of their contents, leaving a comparatively solid mass behind. As is the case generally throughout the oil regions of this State, the geological formation here consists of clay shales, alternating with sandstone, and is highly inclined.

ON SARGENT'S RANCH.

This place is situated a few miles south of the town of Gilroy, in Santa Clara County. The deposits here are located on Tar Creek, along which they extend at intervals for a considerable distance. They occur in much the same manner as those already described, the petroleum oozing from the sandstone and flowing off, becoming inspissated into maltha and asphaltum, large quantities of which have accumulated at different points along the creek. At the first considerable deposits met with going up the creek works have been put up for purifying the bréa by fusion and straining, the apparatus and process employed not differing much from those in use at La Bréa, Los Angeles County. The liquid asphaltum here exudes from the hillside in a thin tarry stream, which has so little motion that it is scarcely perceptible when the weather is cool, but which increases with the temperature of the atmosphere, and, spreading out, it becomes mixed with the black loam that here composes the surface soil, rendering this portion of the material very impure. Much of the asphalt at this place presents a vitreous appearance, like the best quality from Trinidad. Some of the pools formed here are as much as ten feet in diameter, and of unknown depth. In cool weather it is possible to walk over almost every part of these beds, but on warm days, the surface being slightly softened, this is impracticable. When dug up and thrown into heaps, the hard asphaltum, at ordinary temperatures of the atmosphere, gradually softens and spreads out into a thin sheet. Experimenting with a large slab of hard asphaltum in the State Museum, it was placed on four corks, and left so supported for a short time, when the lump sank to the table, imbedding the corks wholly in it.

In digging anywhere beneath the deposits on the Sargent Ranch the earth is found to be permeated with asphaltum, which can be recovered by the usual method of heating in kettles. Even in the bed of the creek masses of the mineral are met with, much of it so hard as to be quite brittle. Mixed with this asphalt are found samples of a mineral resembling ionite. From the lower plateau, where the purifying works are located, some twenty or thirty tons of asphaltum have, one time and another, been taken.

Half a mile further up Tar Creek, other large beds of asphaltum are encountered, having their origin in a line of springs located on the bank of the stream, and about thirty feet above its bed. A few rods above these deposits, many bowlders containing fossils were observed, and some of which were secured, mention thereof being made elsewhere. There is noticeable here a conglomerate and a sandstone cropping, the latter so friable that it can be crushed between the fingers, but neither appear to contain any fossils. From these deposits, seventy-five carloads of asphaltum have been sent to San Francisco.

Proceeding one and one half miles further up the creek, a third and much the largest bed of asphaltum in this series is met with, the deposits at this place covering several acres. The land here, as at the points below, spreads out into a sort of plateau. On the sidehill, above the deposits, are located the supplying springs, many in number. The oil here flows out in sluggish streams, portions of it mixing with the black soil, rendering it very impure, and the whole condensing, first into maltha, hardens at last into asphaltum. In some places, large tarry pools have been formed, in others little mounds of bréa, resembling the tufa deposits of mineral springs. From the surface of these pools, gas escapes in bubbles similar to those observed at the Mud Lakes on the Colorado desert. Here, too, are to be seen the remains of birds and small animals that, getting entangled, have perished in the treacherous tar. From this locality two hundred carloads of asphaltum have been shipped to market. About twenty years ago, a refinery was put up on Sargent's Ranch, at which a good illuminating and a very superior lubricating oil were produced in considerable quantity from petroleum gathered along Tar Creek.

ARAGOTITE.

This mineral, a hydro-carbon, was found by F. E. Durand, in the New Almaden quicksilver mine, and, so far as known, is peculiar to the quicksilver mines of this State. This new mineral, which is of a pure yellow color, was described by Mr. Durand, in a paper read by him before the California Academy of Natural Sciences, April 1, 1882, and possesses the following properties: In a glass closed tube it sublimes and gives off a voluminous sublimate of fine golden yellow needle crystals. Heated quickly it carbonizes and gives residue of carbon, with empyreumatic odor, not attacked by acid. Found in the New Almaden quicksilver mine, Santa Clara County, in dolomite, and with cinnabar in the Redington quicksilver mine, Lake County, and in the California quicksilver mine, Yolo County, all in this State. A sample of this mineral from the California mine, in Yolo County, is represented in the State Museum by No. 338, but it is too small for analysis. "Idriatite," a similar mineral, is found in the quicksilver mines of Idria, Austria.

PRICES, USES, AND CONSUMPTION OF ASPHALTUM.

While we do not employ asphaltum in laying up the walls of either houses or cities, as did the ancients, it is still used at the present day for many purposes—in California, as elsewhere throughout the world, mainly for the construction of street pavements, sidewalks, roofing, cellar floors, for coating water pipes, etc. The quantity consumed in this State amounts to about three thousand five hundred tons per year, the annual receipts at San Francisco reaching two thousand five hundred tons, the most of it coming from Santa Barbara County. About five hundred tons of the above amount are obtained from Corral de Piedra, and smaller quantities from various other deposits in the State. At one time the supply for nearly the whole State was procured from the Carpenteria bed; latterly, however, but little has been shipped from that locality. The Santa Barbara product being preferred by consumers, commands from twenty to thirty per cent more than any other offered on the market. The present wholesale price of asphaltum in San Francisco is $13 per ton for the best, $9 to $11 for a poorer article. The above are somewhat below the usual rates, which in times past have generally ranged from $12 to $16 per ton, having occasionally been as high as $30. The cost of extraction varies from $2 to $3 per ton, according to the hardness of the material, which is sometimes so solid that it has to be blasted out with powder.

SIDEWALKS AND PAVEMENTS.

Although asphaltum for sidewalks is being constantly superseded in San Francisco by artificial stone, its consumption is steadily on the increase, owing to the many new uses to which it is being applied. In many of the large cities of Europe this mineral appears to be growing in favor, not only for sidewalks, but also for street pavements, this being especially the case in London, Paris, and Berlin. In the latter, large sections of old pavements were not long since taken up, and a pavement composed chiefly of asphaltum put down in their place. Asphaltum pavements laid by a San Francisco firm on some of the greatest thoroughfares of London are said to have given entire satisfaction. After many and long trials made with wood, cobbles, granite, basalt, and macadamizing with gravel and jasper, the citizens of San Francisco are looking for a pavement that will last moderately well and yet be free from the objections that lie against the use of the above materials for paving their streets.

The following is the formula generally employed in preparing the material used in the construction of asphaltum sidewalks and pavements in San Francisco: 500 pounds asphaltum, 1 ton gravel, 15 gallons coal tar.

The asphaltum having been melted in a large vat, the gravel and coal tar are added, after which the mixture is ladled out and poured over a layer of soft bricks, or a flooring of redwood boards cut into short sections, and set on end in a bed of sand. As soon as the mass is poured out, it is leveled down and smoothed by passing over it hot flat irons with long wooden handles. In some instances, coarse gravel or small fragments of quartz are introduced into the mixture before being laid on the sidewalk, these being intended to receive the principal wear, and thus preserve the asphaltum.

Robert Skinner, of San Francisco, has invented a process for manufacturing an asphalt pavement-block by compression, and which is briefly described as follows: Calcareous material after being crushed is heated and brought in contact with hot asphaltum. This material is then forced into molds under a pressure of not less than 50 tons, after which, having been cooled in water, it becomes homogeneous. A block manufactured by this method (3606), can be seen in the State Museum.

FOUNDATIONS FOR MACHINERY.

A concrete has lately been used in Europe for constructing the foundations for heavy machinery, for which it has been found to answer an excellent purpose. This style of foundation is prepared in the following manner: A box of the proper size having been made, a layer of hot gritted asphalt is poured in and covered with a stratum of perfectly dry bluestone and rubble; then another layer of the hot asphalt followed by a layer of the bluestone and rubble, till the structure is brought to the required height.

ASPHALTUM WATER PIPES.

In 1870–71, asphaltum pipe was manufactured by J. L. Murphy, at his works on King Street, San Francisco, by coiling burlap, after being passed through a trough filled with melted asphaltum, on a wooden mandrel covered with paper to facilitate its removal. Any desired thickness and strength could be given to the pipe by regulating the length of the cloth in proportion to the size of the pipe required. When used for the water supply of towns, it was made to resist an internal pressure of 500 pounds to the square inch. When taken off the mandrel the pipes were glazed inside, by stopping up one end, pouring in some melted asphaltum and then rolling them rapidly on a table, the superfluous material flowing out at the open end. The table was covered with coke dust, a portion of which adhered to the outside of the pipe, forming a smooth, dry, and hard coating. This pipe was light, durable, and cheap, costing, inclusive of couplings, a sum per foot equal the diameter of the pipe multiplied by ten cents. Thus, two-inch pipe costs twenty cents per foot; four-inch pipe, forty cents per foot, etc.

NOTES.

The following article, on the uses, properties, and different qualities of asphaltum, and the best methods of preparing it, is here given for the reason that it embodies the views of a well known resident of San Francisco, who has had much practical experience on this subject:

ASPHALTUM.

This is one of the most abundant and valuable native products of California. Except in a very few instances, its properties and uses are but imperfectly understood and insufficiently appreciated. When used at all, it is commonly prepared so badly that when applied it soon decays, and fails to answer the purpose intended; whereas, if properly prepared, it is one of the most enduring of substances. I have seen places on the coast, in Santa Barbara County, where the liquid asphaltum, or "maltha," oozing from the banks, has attached itself to the rocks between high and low tide, exposed to the sun, wind, and waves; sometimes dry, sometimes wet; subjecting it to the severest test imaginable; and yet the rock was worn away about it, while the spots covered with asphaltum were perfectly sound and smooth.

In this city, when asphaltum is used for roofing, sidewalks, etc., it is usually prepared very badly, and so as to nearly destroy its best properties. For instance, it is boiled and stirred till most of its virtue is expelled, and it becomes nearly as dry and crumbly as coke; then something is poured in to soften it again—"to temper it," as they say—this something being *coal tar*, which vitiates the asphaltum, poisons it, and destroys all its virtue. Coal tar has no chemical affinity for this mineral, no property in common with it. They are, in fact, about as incongruous as two substances well can be. They will mix mechanically while hot, but they will not stay mixed. The coal tar evaporates in the sun and air, and washes away in the rain, leaving the asphaltum not solid, but honeycombed and porous, disintegrated and crumbly. The coal tar seems to have destroyed the native tenacity of the asphaltum, which soon perishes after this stuff has been eliminated from it.

Let any one interested in this subject observe, as he passes along our streets, after a heavy rain, and he will see, where the streets or sidewalks are laid in asphaltum, little pools of water with an iridescent surface; these colors come from the coal tar, washed by the rains from the mixture of that substance in the asphaltum sidewalks. A little further attention will reveal the fact that this piece of coal-tar-asphaltum sidewalk, which looked so smooth and pretty when first laid, is already growing rough on the surface, the gravel in it becoming loose, as the fabric begins to decay.

The best asphaltum is that which is pure and soft, and most free from sand, dirt, and dry, hard stuff, like coke. It is sometimes found as pure as if it had been carefully refined, as clear and bright as a black glass. The specimens from our California mines are more or less mixed with coarser substances. Sometimes the mass of it appears dry and coke like, as if it had already been cooked too much. This sort sometimes has veins of the stuff running through it, still plastic and fresh; this is the best part of it, and good so far as that goes. When it is dry and crumbly, be sure that the best of it has by some means been wasted.

HOW TO PREPARE IT.

To prepare asphaltum properly for pavements, for instance, it should be cooked for some hours over a slow fire, stirring it the while. Probably superheated steam, or a steam jacket, next the boiler, would be effective, without the danger of burning it, as when the fire comes in direct contact with the vessel containing the mineral.

After cooking gently for awhile, mix with it the residuum of petroleum, from which kerosene has been made. This substance is homogeneous with asphaltum, and the product of the mixture, properly cooked, is a most tenacious substance, which will draw out to a thread, almost imperishable. Its proper temper may be tested by dropping a little of the hot stuff from the kettle into cold water. If it will then pull out like warm taffy into a string, it is in perfect condition for use.

Such a compound, well mixed, while hot, with finely crushed rock, dried and heated, and thoroughly tamped or rolled while the mass is still hot, makes a good sidewalk and pavement; smooth, and capable of enduring a great amount of wear with the least apparent waste, decay, or signs of abrasion.

A specimen of such pavement may be seen in front of the engine house of the California Street cable cars, corner of Larkin and California Streets, which, after about six years use, looks as sound as when first laid. Another piece of pavement, consisting of wooden blocks covered with a mixture of asphaltum and crushed rock, can be seen on Sacramento Street west of Montgomery. It has been there more than five years, and is still in perfect condition, no repairs having been required. It remains smooth, is noiseless, clean, and in the long run the cheapest of all pavements.

It would furnish the economist a useful field of inquiry to ascertain the relative cost and benefits of the ordinary cobble, granite, or basalt pavement with a pavement constructed of crushed rock and asphaltum. In a great populous growing city like San Francisco the *disadvantages* of a rough stone pavement consist in its being *noisy*, dirty, and in its *cruelty* to horses, which not only suffer more but are worn out twice as soon as where traveling on a smooth slightly yielding pavement. Then there is the loss of time, greater wear of vehicles, and increased discomforts to be considered, the whole aggregating a very important item in the account. A smooth pavement is just the reverse of all this, and when the advantages of such a pavement are considered we should find in a great city like this, after paying all the cost of construction and repairs, that there would be, at the end of every year, probably more than a million dollars to the credit of the smooth pavement, to say nothing of additional comfort, cleanliness, and quiet.

Asphaltum, well prepared, makes a durable coating for iron water pipes, inside and out, and when it comes to be better understood its uses will doubtless extend to a variety of things not now thought of. As it has served to protect the rocks on the beach of Santa Barbara, why would it not protect the granite stone work at Fort Point, which seems to be wearing away in the sea wash so rapidly?

From an extensive deposit of asphaltum located about eight miles from Santa Cruz, material has lately been taken for paving the streets of that town. The mineral, which in its natural state is here found mixed with sand, is heated until it becomes plastic, a little water having first been added. In this condition it is spread out over a stratum of broken rock, stamped down, and rolled while still hot. Thus far it has answered every expectation, and promises to prove a durable, as it certainly is a smooth, clean, and noiseless pavement.

The following is an analysis of a sample of maltha from the tar wells of Santa Barbara, made by J. M. Robertson:

Indorsed: Liquid mineral tar from Biggs' ranch, Carpenteria, Santa Barbara, Cal.

S. W. HOLLADAY,
302 Montgomery Street.

SAN FRANCISCO, July 1, 1884.

Nitrogen	2.25
Carbon	70.00
Hydrogen	10.00
Oxygen	8.50
Ash	·9.00
Insoluble matter, whitish	.25
Centesimally	100.00

Wholly soluble in ether. Partly soluble in alcohol.

J. M. ROBERTSON, Chemist.

SAN FRANCISCO, August 20, 1875.

The following lists comprise the countries and localities in which petroleum has been found in greater or less quantities:

UNITED STATES.

Alabama, California, Colorado, Georgia, Kentucky, Maryland, New York, Ohio, Oregon, Pennsylvania, Tennessee, Texas, Virginia, West Virginia, Wyoming.

CALIFORNIA.

So far as surface indications go, petroleum has a wide range in California, springs and pools of the fluid being encountered in nearly all the coast and also in some of the inland counties of the State. In the more southerly tier of counties it generally occurs in connection with extensive beds of asphaltum or *bréa*, this being also the region of the more productive oil wells. To the extent above denoted petroleum has been found in the following counties in this State, viz.: Alameda, Colusa, Contra Costa, Humboldt, Kern, Lake, Los Angeles, Mendocino, Napa, San Bernardino, San Luis Obispo, San Mateo, Santa Barbara, Santa Clara, Santa Cruz, Sonoma, Tulare, and Ventura.

FOREIGN COUNTRIES.

Argentine Republic, Burmah (Rangoon), Canada, Cuba, Germany, France, Italy, Mexico, New Zealand, Persia, Russia (Baku), Spain, Switzerland, Trinidad, United States of Colombia, and Venezuela.

HISTORY OF PETROLEUM IN CALIFORNIA.

Petroleum has been known to exist in California since the earliest settlement of the country. The black "maltha" oozing from the earth and standing in pools, or flowing from springs on the hillsides, was evidence of the fact; still no attempt was made toward utilizing this valuable material in a large way until 1857. About this date, as near as I can gather, Mr. Charles Morrell, a druggist in San Francisco, made the first attempt to produce coal oil from California crude materials. He commenced operations in Santa Barbara County, near the line of Ventura County, in the vicinity of Carpenteria. The bluff on the seashore is about fifty feet above tide level, and from eight to ten feet below the surface there occurs a stratum of coarse sand, of a yellow color, two feet thick and lying horizontally, or nearly so, that is saturated with maltha, mineral tar, or liquid asphaltum. Mr. Morrell erected quite extensive works, well supplied with cast-iron retorts, furnaces, etc., in which the crude material was refined by distillation, and oil produced; but for some reason not now known, the enterprise was a failure.

In 1856 a San Francisco company commenced working at the Brea ranch, near Los Angeles, and tried to obtain refined oil; the particulars of their operations are not now obtainable.

Andreas Pico knew the locality now called Pico Cañon, Los Angeles County, for some years before Mr. Morrell established his refinery, and had made oil for the San Fernando Mission in a small way, in a copper still and worm. He was probably the pioneer coal oil manufacturer of the State.

In 1857, W. W. Jenkins, W. C. Wiley, and Sanford Lyon, visited Pico Cañon to look for mineral and oil. Francisco Lopez, former steward of the San Buenaventura Mission, and superintendent of the gold placers, had informed them that there was oil, which they found oozing from the ground in what are now called Pico, Hooper, Sespe, Casteca or Pine, and Piru Cañons. No further attempts to produce coal oil appear to have been made until 1864; when the Buena Vista Petroleum Company was incorporated, in February, but active operations were not begun by them until the following year, when they commenced work in Tulare County under the title of the Buena Vista and the First National Petroleum Companies.

April 8, 1865, Professor Silliman published a letter to the Hon. D. H. Harris, entitled, "California Oil not Asphaltum." This letter was afterwards printed in the *Mining and Scientific Press*. Silliman quoted Professor Brewer, to the effect that the oil at Humboldt was light enough to burn quite well in a chimney lamp without refining. Also, that one spring on Azuza (now Sespe) Mountain, behind San Buenaventura, furnished an oil so thin that Brewer had seen it in use in a common lamp without rectification. Professor Silliman wrote that he had obtained ninety-six per cent of good oil from a sample of it. The publication of this letter had great influence in stimulating the search for and study of California oils. None of the wells had at this time reached any considerable depth, but there was great activity in prospecting for oil.

About this time, J. C. Cherry came to California, having in contemplation the erection of an oil refinery. He visited and made a favorable report on the property of the Point Arenas Oil Company.

The San Fernando Petroleum and Mining District was located in June, 1865, with Mr. C. Leaming, Recorder, who still holds that office, and the San Fernando Petroleum and Mining Company incorporated.

During 1865 operations were commenced on Mattole Creek, Humboldt County, by the North Fork Oil Company, and on August third, at the Mattole well, a burst of oil and gas rose several feet above the opening. This action lasted for a few minutes only, but left the well full of oil. The next day it was pumped out, and the same action was repeated, as was the case on the fifth and sixth days. Thirty barrels of oil were shipped to San Francisco. "Six twenty-gallon casks of crude oil," by another statement, was the first shipment of oil received from the north.

The Bolinas Petroleum Company began operations at Bolinas Bay. The works were situated in the Arroyo Honda, on the Bolinas grant.

The San Pablo Petroleum Company, located one mile from San Pablo, Contra Costa County.

At the Adams well, Mount Diablo, San Joaquin County, active operations were commenced. The Adams was the pioneer in that district.

Near Lexington, Santa Clara County, some Portuguese sunk an open shaft 135 feet deep; no results were obtained beyond indications; the prospect was for coal.

In Moody Gulch, Santa Clara County, the McLeran(?) well was sunk to a depth of 500 feet, and about one barrel of oil obtained per day. Moody Gulch was named from Moody's sawmill that once stood there.

Oil was discovered on Bell's ranch, 15 miles below Halfmoon Bay, San Mateo County, and at Purissima Creek.

The Pennsylvania Petroleum Company commenced operations near the seacoast, six miles south of Santa Cruz.

The Philadelphia and California Petroleum and Santa Barbara and California Petroleum Companies were incorporated.

Rowe and Fleeson sunk a well one mile below Simmons Spring, Sulphur Creek, Colusa County.

The Antelope Valley and the Pioneer Oil Company, Colusa County, commenced operations for the second time.

The Los Angeles Petroleum Oil Company began sinking a well by steam power, and on April twenty-eighth were down 130 feet.

The Paragon Petroleum Company commenced operations, and the Humboldt Oil Company was incorporated.

In May forty cases of crude oil were sent to San Francisco from the San Joaquin and Pacific Oil Companies of Tulare County, which was shipped east on the steamer of the eighteenth.

In this year there was published a tabular statement, naming the oil companies to the number of sixty-five. Nominal capital, $45,000,000.

In 1866 Mr. Charles Stott began work on Santa Paula Creek, Ventura County, at the base of Sulphur Mountain, and erected a refinery on a small scale. He made several thousand gallons of illuminating oil, and then gave up the enterprise because it did not pay. October twenty-second, the San Francisco *Alta* published an article on petroleum and refineries, giving Charles Stott credit for refining the first oil in this State.

In this year there were two refineries established in San Francisco, one owned by Hayward & Coleman, the other by Stanford Bros. Neither of these establishments achieved any considerable success, and were eventually abandoned.

Mr. —— Polhemus, also, had a refinery at Los Angeles. A portion of the crude oil which he refined was obtained from wells near the town of Los Angeles, and some was hauled by teams from Pico Cañon.

Mr. Hughes bored for oil in Pico Cañon, and struck a flowing well at 140 feet, but the tools became fast in the well and could not be extricated.

A well was sunk on the Potrero, in San Francisco, but the result was not satisfactory. There was considerable excitement about oil during this year.

The "Pioneer Petroleum and Refining Company," of San Francisco, was incorporated. Charles Stott, David Hunter, and H. P. Wakelee, Trustees.

In 1867 Lyon and Jenkins returned to the claims they had examined ten years before. Jenkins went to Sespe and Piru; Lyon remained at Pico. Lyon's Station was named from him; he died in 1883.

The "Fargo" well, sunk at Moody Gulch to a depth of 400 feet, yielded one barrel per day; and from a well at Griswold's place, two miles from Lexington, 500 feet deep, some oil and salt water were obtained.

In a well sunk in Colusa County the water in the well was seen to rise like a tide at 3 P. M. and at 6 A. M. At Antelope Valley, 18 miles north of Oil Center, in the same county, there is a salt pond, and salt water is found in the oil wells. At this time eight oil wells had been sunk in Colusa County.

On January twenty-eighth, twelve barrels of crude oil were shipped from Pico Cañon, Los Angeles County.

The following account of the operations of the Buena Vista Petroleum Company—whose oil claims, comprising some twelve to sixteen hundred acres, are situated in Kern County, west side of Tulare Valley—is of interest. The exact location is Township 30 south, Range 22 east, Sections 19, 20, and 29, and in Township 30 south, Range 21 east, Sections 12 and 13. Previous to 1866, Mr. Stephen Bond and Mr. E. Benoist commenced a well on the flat below the tar springs on the company's claims. At a depth of sixteen to eighteen feet, in raising the auger they turned it the wrong way and unscrewed and lost the bit, which accident stopped the work.

In 1866 the Buena Vista Company set a still with a daily capacity of 300 gallons near a large spring of good water, three miles from the oil springs. The company attempted to sink a well for water in a more convenient location but did not succeed in obtaining it. For thirty feet or more the formation was alternate layers of shale, sand, and asphaltum; below thirty feet was a three-foot stratum of asphaltum very difficult to penetrate, but no water. Two adobe buildings were erected, one for the refinery, the other for the workmen. The oil belt lies along a low range of hills for several miles north and south, on which sulphur springs are quite numerous. Most of the oil croppings are from 200 to 500 feet above the level of the valley. At the Buena Vista springs the oil has flowed out and covered several acres in the form of glossy black asphaltum. There are numerous bubbling tar springs on the flat, from which liquid asphalt or oil flows and gases emanate. Sometimes the imprisoned gases form a globular bubble in the thick oil a foot or more in diameter, which eventually bursts and the tarry liquid subsides again to its level. The asphalt stream extends half a mile or more over the sandstone and to the valley below. The crude oil for the refinery was taken from pits or shafts sunk from 16 to 18 feet deep. There were also several shallow pits or wells which soon filled with oil and water. At the bottom of the shafts a quicksand of oil, water, and sand was met with which could not be overcome by curbing, or otherwise controlled. An open cut was then made into the hill, but a solid formation of sandstone and thick beds of asphaltum were met with. The cut was 7 to 8 feet deep and 4 wide, from which some tarry asphaltum was obtained and distilled. At one time, from the shafts and cut, it was believed that from 5 to 8 barrels a day could be collected. Oil procured from the surface marked 10 to 12 degrees Beaumé, at a depth of 10 feet in the shafts it marked 12 to 14 degrees, and at 20 to 30 feet in depth an oil was found as light as 21 degrees.

Three thousand to four thousand gallons of refined oil were produced. In the distillation the following results were obtained: First run five to seven per cent from forty-seven to forty-three degrees, forty per cent from forty to thirty degrees, thirty-five to forty per cent from twenty to sixteen degrees. The residue left in the still was soft asphaltum, which could be removed without difficulty. They generally ran off from eighty-five to ninety per cent from the charged still, when the residue would continue to run off from the tap while hot. Many difficulties met with by the company caused the work to be abandoned. Freight was high, $60 to $70 per ton to San Luis Obispo, and from $15 to $20 more to San Francisco. The nearest fuel or timber were the forests of the Santa Meta Mountains, lying thirty miles south. From the time the company discontinued work nothing has been done at this locality. Many bones of animals, thought to be fossil, were found in the vicinity. In this year Professor Silliman wrote his celebrated paper on California petroleum, which has called forth so much comment. It was published in *Silliman's Journal*, previous to its being read before the California Academy of Sciences, April 1, 1867, for which reason it was not published in the proceedings of that society. The following are extracts from a condensation of the paper, which appeared in the *Mining and Scientific Press*, April 6, 1867. The experiments were made on a sample of oil from Mattole Creek, Humboldt County, a thick viscid maltha, having a density of .980=31° B. By fractional distillation he obtained a series of light and heavy oils, ranging from .700 to .918 specific gravity. No paraffine was obtained by freezing with a mixture of ice and salt, from which he drew the conclusion that there was none of that substance in the California oils. The light oils obtained were 12.96, 14.56, and 18.96 per cent of the crude oil. It was his opinion that the oil of California could not compete with the oils of Pennsylvania at the prices then ruling, but he believed that our heavy oils would be extensively utilized as a fuel, in which prediction he has been sustained by history, has been shown.

Among the specimens from California, sent to the Paris Exposition of 1867, were petroleum from Mattole, Humboldt County; Joel's Flat, Noble Springs, Santa Barbara County; Wiley's Spring, San Fernando Mountain (Pico Cañon), Hughes' Spring, and Pico Spring, Los Angeles County; Hayward & Coleman's claim, Sulphur Mountain, Ventura County; Stanford Brothers' claim, same locality; from Canada Larga, Santa Barbara County; from Santa Cruz County; Bear Creek, Colusa County, and Charles Stott's claim, Santa Barbara County.

Experiments were made at Corral Hollow, San Joaquin County, to distil coal oil from shale, which did not prove a success.

In 1868 Mr. —— Davis leased the Wiley Springs in the San Fernando Mountain. He collected all the oil he could and sent it to the Metropolitan Gas Works in San Francisco for about a year. Metropolitan Gas Company's office was at that time at 810 Montgomery Street, San Francisco.

In 1869, the first work was done at Pico Cañon, by Mr. Hughes, who put down a spring-pole well called the Pico Well. A similar well was sunk about the same time at Wiley Springs. Wiley Cañon is three miles northeast from Pico Cañon.

In 1871, petroleum was discovered on the Augmentation Ranch, Soquel, Santa Cruz County. Oil was also found in Livermore Valley, Alameda County.

In 1872, Charles Stott again worked the Sulphur Mountain property in Ventura County; this time with better success.

In 1873, the Star Oil Company, of Los Angeles, built their first still in San Francisco, and shipped it to Los Angeles County. The works were established at Lyons Station, under the superintendence of Captain William B. Smith, refiner. This was one mile from the present Newhall Station, and was the foundation of the present refinery at Pico. Wood was used as fuel. There were many different ideas as to the nature of the oil and the mode of purification. No satisfactory results were obtained at this time, and in 1876 the works were sold to Scott & Baker, who also failed to make them pay. Mr. Shoemaker succeeded them, but did not produce oil in sufficient quantity to be profitable. Mr. J. A. Scott then took the refinery, and met with fair success.

In 1874 Messrs. Temple, Moore, and Pico, worked in Pico Cañon. The oil they obtained was sent to the refinery at Lyons Station, which was subsequently removed to Pico. At this time there was considerable activity in the production of petroleum at Sulphur Mountain, Ventura County, so named from the numerous sulphur springs. Hayward's claim produced ten barrels daily of 32 gravity oil. Stanford's, six barrels daily; Santa Paula Oil Company, ten barrels daily; San Fernando Company, near Canulos, about ten barrels daily. All the oil was obtained from natural flows. Two hundred barrels per month was used by the Central Pacific Railroad for lubricating purposes, but beyond this there was no demand for the crude material. At this time there were also some new oil springs discovered at Sespe.

During the year 1876 the Star Oil Company was engaged in sinking wells in Pico Cañon. The yield of the district amounted to forty barrels per day.

In 1877, the California Star Oil Company, of Los Angeles County, under the management of J. A. Scott, produced twenty barrels of refined oil daily at the Pico refinery. The Ventura wells were then producing eighty barrels daily, and those of Pico Cañon from forty to fifty barrels. Work of development by steam machinery commenced at this locality.

In 1878, Chas. N. Felton and P. C. McPherson commenced work in Moody Gulch on the old Boyer well. At 700 feet a rush of oil and gas occurred which rose 100 feet above the mouth of the well and 100 barrels of oil were supposed to have been lost. For some time after 60 barrels of oil per day were pumped from this well, which had a gravity of from 46 to 47 degrees Beaumé. The oil was sent to the Pico refinery, near Newhall, Los Angeles County. In September of this year, in a communication to the *Mining and Scientific Press*, Mr. Edward Madden, an oil expert, stated that the oil of Ventura County was inferior to that of Pennsylvania as an illuminator, but superior as a lubricator.

In the same paper he gives the production of the Star Oil Works at 150 barrels per day, and the yearly consumption of California at 3,500,000 gallons, valued at $1,000,000. His opinion, based on surface indications, was that the southern portion of Los Angeles County was full of oil.

October, 1879, the *San José Mercury* contained an account of the successful prospecting for oil in Moody Gulch, Santa Clara County, Santa Cruz Mountains. Dall Brothers, employed by the Santa Clara Petroleum Company, at a depth of 600 feet struck a vein of oil which spouted 100 feet above the top of the well. Having no tanks, etc., 100 barrels or more of oil ran to waste. After a time the flow subsided but recurred again at intervals. This strike created a great excitement.

At this time, there were five wells at Pico from 200 to 600 feet deep; eight wells in Ventura County on ex-mission lands, from 100 to 200 feet deep, all yielding oil by pumping, in all, 20 barrels per day; and one well at Sespe 1,500 feet deep, yielding 100 barrels per day. September tenth, Pacific Coast Oil Company of San Francisco was incorporated.

In 1881, A. C. Dietz & Company established the Berkeley Lubricating Oil Works, for the manufacture of lubricating oils from California material brought from Ventura County. They turned out 100 barrels per day. In February, there were seven new wells being drilled in the State, and the product during the past year had doubled. The oil business in California was at this time of greater magnitude than was generally supposed. Citizens of Los Angeles, Ventura, and Santa Barbara Counties, signed a petition asking the U. S. Government to instruct Clarence King, Geologist, to make surveys of the oil districts; and to note the progress of development since 1865. They represented that a belt of oil shale extended for eighty miles in length, from the San Fernando district in Los Angeles, through the Sespe, Santa Paula, Ojai, and Sulphur mountains in Ventura County, and the Carpenteria and Santa Barbara districts, terminating in the Pacific Ocean at Goleta, in Santa Barbara County. That, although the indications were encouraging, yet the work had been done somewhat blindly, and without scientific guidance; much money had for this reason been lost, believed to be as much as $1,000,000 with unsatisfactory results. Practical oil men, and capitalists, familiar with the subject, were of the opinion that the results of their work indicate that large quantities of petroleum of good quality exist, but that they fear to progress without scientific guidance. In consideration of the importance to the whole country of the vast interests involved, they felt they had a right to ask aid from the General Government.

This year (1884), Mr. Lyman Stewart, of the firm of Harrison & Stewart, informed the State Mineralogist that the Pennsylvania company of which he is a member has invested, in Pico Cañon and elsewhere in Los Angeles and other counties, $130,000, a large portion of which is a loss. They sunk six wells in Pico Cañon and one at Santa Paula, all of which are "dry holes." Mr. Stewart is from Titusville, Pennsylvania. He brought out thirty men, all skilled workmen. Some of the wells sunk by them were very deep. He said that if he could obtain oil in one well, the company would soon make up the loss. They are now boring in Pico Cañon, near the Pico well.

PETROLEUM IN CALIFORNIA—LOS ANGELES COUNTY.

The Chandler Oil Mining Company, of Los Angeles, was incorporated February, 1884, George Chaffey, President, C. H. Howland, Secretary, B. Chandler, Superintendent. The company's wells are at Petrolia, Section 5, Township 3 south, Range 9 west. They commenced operations on Puente Ranch, Section 1, Township 3 south, Range 10 west, and obtained oil at from 100 to 300 feet, sp. gr.=15° to

30° B. One well produced 150 barrels, which sells for $4 50 to $12 per barrel. Mr. Chandler informed me that within two years 5,000 barrels had been produced at Petrolia, which I visited in May, 1884. Two wells were being sunk: Number one was 290 feet deep; number two was 240 feet deep. From number one quite a quantity of "black tar oil" (maltha) had been pumped. A tank, holding from seven to ten barrels, was standing full. Common bréa, which contains what seems to be ionite, is burned under the steam boiler, and is the only fuel used. (The presence of ionite was also observed at Sargent, Santa Clara County.) The wells at Petrolia are on small foothill elevations above Anaheim, direction or trend of the hills is about east by south. A small creek runs down south by west to the plains. On both sides bréa has run down and formed terraces, as at Sargent, and the "black tar" is similar. Of the bréa there are several varieties: Cellular, like volcanic scoria, and mixed with sand; several grades pure "black tar," and some brown and light, like ionite, which it seems to be. At Swallow Point the soft sandstones resemble those at Pico Cañon. In several directions from the oil wells may be seen extensive patches of bréa, which have flowed from the hillsides.

Mr. J. W. Snow's well is about a mile from Petrolia. It is 550 feet deep, but unfortunately for the owner it is a "dry hole." There are large fields of bréa contiguous containing much of what is thought to be ionite. The sides of the cañon in which the well lies are sandstones and conglomerates, with rather thick seams of selenite interstratified. The stratification is confused and broken so that no section could be found exposed. A shark's tooth described elsewhere was found at this point.

The well was first a square shaft, 44 feet deep, from the bottom of which a six-inch well was sunk through soft sandstone. At 250 feet and for 150 feet lower probably, sandstone was cut through. The sand is like that in the bréa. High up the cañon sandrocks were found seemingly in place, dip 32°, strike N.W. to W.N.W. The tertiary fossils found here are described elsewhere.

SITES OF THE MORE PRODUCTIVE WELLS—PICO CAÑON.

At this place, seven miles southeast from the town of Newhall, Los Angeles County, the Pacific Coast Oil Company have sunk a number of wells, 16 of which are producing more or less oil, some of them yielding as much as 75 barrels per day. Besides the wells already producing several others are being put down. The borings here reach to various depths, many of the wells being down over 1,000 feet. Several have been sunk from twelve to sixteen hundred feet, and one has reached a depth of 1,900 feet. Many pumps and derricks can be seen here in constant operation, the former lifting the crude oil from the wells that are already yielding, and the latter working the boring apparatus of those being put down. The oil at this locality is found on one side of an anticlinal fold or break, as it is called, and after being pumped to the surface is collected from the various wells and conveyed by a four-inch iron pipe to the large receiving tank, located centrally to the group, whence it is carried by a two-inch pipe to the company's refinery, near Newhall. Some of these wells, after flowing sparingly for a time, again yield more freely, these periods of partial intermission occurring without much regularity.

The characteristic sandstone and conglomerates appear here, samples of which were obtained for the State Museum. Bréa deposits were also noticed on the adjacent hillside. In the vicinity of the wells are located the workmen's quarters, shops, and other outbuildings of the company; the manager of these works is Mr. R. Craig.

The oil wells, refineries, and plant of the Pacific Coast Oil Company, of San Francisco, C. N. Felton, President, D. G. Scofield, Auditor, E. Wheaton, Secretary, are the most extensive and successful on the Pacific Coast. I addressed a letter to this company, asking certain questions, the answers to which I thought would be of interest to the people of the State. My questions, with the answers returned by the President of the company, are given below:

QUESTIONS.

Question 1. When was the Pacific Coast Oil Company incorporated?
Q. 2. When was work commenced in Pico Cañon, Los Angeles County?
Q. 3. What was the cost of the two refineries?
Q. 4. How much capital is invested?
Q. 5. Is the table of production in Williams' "Mineral Resources" correct (1878 to 1882 inclusive, 197,484 barrels)?
Q. 6. What has been the production since 1882?
Q. 7. How much was produced before 1878?
Q. 8. What is the daily average yield at Pico Cañon, Los Angeles County?
Q. 9. What has been produced in Moody Gulch, Santa Clara County?
Q. 10. To what extent has California oil decreased importation?
Q. 11. Is any California oil exported, and where?
Q. 12. What is the number of producing oil companies in the State?

ANSWERS.

Answer 1. September 10, 1879.
A. 2. Work was commenced in Pico Cañon in 1875, by the drilling of three shallow wells with spring pole, all of which yielded oil at depths of from ninety to two hundred and fifty feet. Actual work of development commenced with steam machinery in 1877.
A. 3. Refinery at Alameda Point cost $160,117 43; refinery at Newhall cost $25,266 64.
A. 4. Amount of capital invested, say, $2,500,000.
A. 5. Cannot say; have not seen table referred to.
A. 6. 190,540 barrels.
A. 7. See Journal of Commerce Annual for 1883.
A. 8. 560 barrels.
A. 9. About 24,000 barrels.
A. 10. About 33⅓ per cent of all kinds.
A. 11. Exported to British Columbia, Sandwich Islands, Mexico, and Society Islands.
A. 12. Companies actually producing oil: Pacific Coast Oil Company, San Francisco Petroleum Company, California Star Oil Works Company, Mission Transfer Company, Santa Clara Petroleum Company. Numerous companies have been formed, some have drilled shallow wells, but the above are all that have successfully produced oil.

TUNITAS CREEK, SAN MATEO COUNTY.

This oil district visited April 21, 1884, is situated in San Mateo County, being in Township 6 south, Range 5 west, Section 25. Several wells have been sunk here, one named the Balmoral, to a depth of 586 feet, without obtaining oil. From another, not named, light green oil was being pumped from a depth of 550 feet. The following phenomena, as furnished me by Mr. H. W. Bodwell, in charge of the work, were observed in sinking the Balmoral well:

From 100 feet to 140 feet showing of oil; best about 130 feet.
Two hundred and thirty-five feet, abundant salt water.
Two hundred and fifty-six feet to two hundred and eighty feet, showing of oil and gas.
Three hundred and eighty-six feet, smells strongly of gas.
Four hundred and thirty feet to bottom (586 feet), gas quite abundant.
Four hundred and sixty feet, black soot appeared on water very abundantly.
Four hundred and seventy feet, showing of oil.

Crude petroleum is used as a fuel under the boilers here, being applied in the usual manner with a jet of steam.

MOODY GULCH, SANTA CLARA COUNTY.

Visited this locality, which lies about two miles southeasterly from Alma, Santa Clara County, April 17, 1884. The deposits here are owned by the Santa Clara Petroleum Company, who have sunk two wells at the same level, but on opposite sides of the cañon, and about eighty-five feet apart, the elevation here being 970 feet above sea level. Each of these wells has been furnished with a hand windlass, steam engine, pump, etc. A tank, connected with the wells, has been put up here. From this tank a two-inch iron pipe extends to another and larger tank, located some distance down the cañon, and from which the oil is conveyed by a similar pipe, thence to the railroad, about one mile distant. These wells are named Moody Nos. 1 and 2, and though idle at the time of my visit, have produced considerable oil, judging from what could be seen and learned. The direction of the cañon changes at this point and continues towards the top of the hill, about W.N.W.

At a height of 1,040 feet another well, with derrick, engine, pump, etc., is encountered. But, as below, nothing here was being done, the machinery being partially dismantled and the whole place much neglected; though here, too, some oil had evidently been produced.

The next well, No. 7, was met with at an altitude of 1,120 feet. Here the engine was working and the water being bailed out, preparatory to further sinking. Though no oil in quantity had been produced here, I examined some brought up with the water, and found it to be thin and of a green color and good smell. There are signs of this well having at some time been on fire, though I was unable to learn much about its present condition or past history.

Ascending the cañon, the last well in this series was reached at a height of 1,160 feet, and about 200 feet below the summit of the hill. Here, some oil contained in a tank was examined and found to be fluid, and of good smell and color, quite unlike the tarry liquid seen at the Sargent Ranch. The power here is supplied by a steam engine of from eight to ten horse-power. From the main pulley, a belt extends to another near the mill. The pump is worked by a crank and beam, the machine being controlled by a friction pulley shifted by a lever. On the throttle of the engine there is fixed a small pulley, and a still smaller one near the pump where the fireman stands. A rope transfers the power from the larger to the smaller of these pulleys, enabling the fireman to shut off or turn on the steam at will, without moving from his station. The engine can also be reversed by the motion of a lever which changes the pitman from one eccentric to another. At the top of the derrick, standing over the well, there is placed a large iron pulley over which a rope passes, and running through a block near the floor extends to a winding pulley driven by the engine. There is also a heavier and shorter rope, and a hand-windlass, used in boring, drilling, etc. The oil is pumped first into local tanks, when it is carried by gravity to the collecting tank. Here the water having been drawn off, it is passed to the lower tank, and, finally, to the railroad.

REFINERIES.

The Pacific Coast Oil Company has erected works, for refining crude petroleum, at Pico, near the town of Newhall, Los Angeles County, and which were visited May 11, 1884, which is referred to in the "History of Petroleum in California." The offices of the company are located in the town of Newhall. The oil here treated is obtained from the wells in Pico Cañon, seven miles distant, whence it is conveyed through a two-inch iron pipe to a large iron tank or receiver. From this receiver it is again carried by gravity through iron pipes to the refinery. From the refinery the product and by-products are conducted to storage tanks. From these tanks pipes lead to the side-track of the railroad, these pipes being sufficiently elevated to discharge the oil into box cars, in each end of which there is a boiler iron tank of a capacity of 50 barrels—a carload consisting of 100 barrels of oil. The globe valves are reached from an elevated platform placed along the side-track. The stream of oil is guided into the manhole opening in the car tank by loose elbows and joints of pipe (practically a goose-neck). The manhole plates screw down. Elbows below are furnished with discharging cock, three inches in diameter, to which flexible tubes being attached the tanks are readily emptied of their contents.

Portions of the crude oil from this locality are sent to San Francisco, Los Angeles, Colton, Arizona, and elsewhere. It is used at Colton for burning lime, and at Los Angeles for fuel in electric light works and in burning brick. The refined oil is sold for local use in the southern portions of California and in Arizona. It is water white and burns freely in the mechanical lamp. Sp. gr. 797=46° B., which is rather heavy for a good burning fluid in the ordinary lamps. This Newhall refinery was erected before the extensive works at Alameda Point were put up. Though not protected by a building such is the mildness of the climate that no serious inconvenience has been experienced from this deficiency.

About four and a half years since, Mr. A. E. Edwards put up a refinery in the valley of the Santa Clara River, Ventura County, at which oil from the wells on the Little Sespe was treated. For the conveyance of the oil a pipe was laid down along the Little and the Big Sespe, connecting the wells with the refinery. The crude oil from these wells had a specific gravity of 42°. The refined was water white and burned well in lamps, according to an editorial statement in the Los Angeles *Commercial*. These wells lie in Section 6, Township 4 north, and Range 20 west, San Bernardino meridian.

May 5, 1884, I visited the refinery of the Pacific Coast Oil Works at Alameda Point, Woodstock Refinery, G. R. Miller, Superintendent. The works are contained in an area of 30 acres, in which there is ample room to increase the capacity of the works as occasion may require, which depends in a great measure on the supply of crude oil that can be obtained in the State.

The large retort now in use has a capacity of 850 barrels. The crude oil is forced in from the receiving tanks by steam pumps. The heat is generated under the still by burning jets of refuse petroleum, forced in by a jet of steam. The lighter oils first come over, and are conveyed through pipes laid in wooden boxes surrounded by water. The condenser is, in effect, a Liebig cooler on a very large scale.

The pipes extend for several hundred feet to the receiving house, from which the oil is conveyed to storage tanks of boiler iron placed in convenient localities.

The first distillation is not continued to dryness, but is discontinued when the residue is of a certain consistence, suitable for burning, when the still is allowed to cool to 300° or thereabout, after which the tarry residue is pumped into receiving tanks and used as fuel. Near the large retort, there is one of different construction, which is continuous in its action. It holds 80 barrels, but the daily capacity is 300 barrels.

There are two stills heated by steam, and used for fractional distillation of the first distillate. The products pass through the same cooler, and are received in the receiving room, and passed to the different tanks.

The fractional distillation is managed by means of an appliance, called "observation boxes," in which the operation can be seen. At the proper time the distillate, when it has attained a certain gravity, is diverted into different pipes leading to receiving tanks. The observation boxes are of plate glass.

There are fourteen receiving tanks of various sizes, one being devoted to the storage of oils from Santa Cruz County—others for the southern counties.

In one part of the inclosure are two elevated tanks, in which the oils are mixed with chemicals, by which they are refined. In octagonal buildings, with glass set in the roof and sides, there are two bleaching tanks, with a capacity of one thousand barrels each, in which the refined oils are exposed to the sunlight for a time, which is one operation in the process of refining.

In the boiler-house there are two large boilers, heated by refuse petroleum, blown in by a jet of steam and ignited. The consumption of carbon is so perfect that no smoke is seen to escape from the chimneys.

Mr. Miller made some experiments in the direction of burning brick by petroleum fuel, with only partial success; but the results of the experiments were such that he thinks the next will succeed, and that the cost of burning brick will be much abridged.

The Pacific Coast Oil Company have not succeeded in supplanting the eastern market, but have stopped the importation of lubricating oils, naphthas, and benzines to the extent of one third. From the fuel tanks a portion not required for burning, including "bottoms," is at intervals pumped into six stills, heated by open fires, from which a heavy lubricating oil is driven over, leaving in the still at pleasure either a pure asphalt or a coke. The coke has the appearance of the finest coke from the manufacture of coal gas, and the asphaltum is free from sand and suitable for many purposes, including the manufacture of varnish for the protection of iron. The lubricating oil is kept in a large cylindrical horizontal tank of boiler-iron partly imbedded in the ground.

The works are situated on the Southern Pacific Coast Railroad, from which a branch extends to the warehouses. The near proximity of the shores of the bay not only affords an escape for refuse, but gives facility for the approach of barges and sea-going vessels.

GEOLOGY OF THE CALIFORNIA OIL REGIONS.

My examination of the more important localities at which petroleum occurs in California was necessarily made with such haste that it would be premature attempting at this time to write much on the subject of their geology. It is to be hoped, however, that leisure and opportunity will be found to make more thorough examinations thereof in the future. Pico Cañon and Tunitas Creek offer special facilities for making geological sections, the rocks here lying in such positions that they could be readily measured.

As shown by the fossils collected, the localities visited belong to the tertiary age. The sedimentary rocks observed are highly interesting, and will hereafter be carefully studied. At Pico Cañon the sand rocks are stratified with much regularity, and are interstratified with plates or seams of gypsum (selenite), as seen also at Temple Street cut in the city of Los Angeles. There occur here, also, a black shale and a coarse conglomerate, but no fossils were noticed in the vicinity of the wells, though some are to be found at a short distance. There is evidence that this neighborhood has at some period been subjected to violent water action. That this happened at irregular intervals is shown by the unequal thickness of the various strata, and the material of which they are formed, some being quite thin and consisting of the finest river silt, while others are much thicker and composed wholly of coarse gravel. They were originally, no doubt, deposited on the bottom of a tertiary sea, and very likely at the mouth of some great "dead river." They were afterwards folded, and at a still later period, broken, as we now find them. In color this rock varies from gray to distinct yellow. Specimens were obtained and preserved for chemical and microscopic examination and study.

At the west end of the San Fernando tunnel, two miles south of Newhall, a sedimentary sandstone, similar to that noticed at San José, Los Angeles, and Pico Cañon, crops boldly, and can be seen in passing on the cars, extending for many miles. This sandstone abounds with fossils. They also appear plentifully in a cut made by a small creek near by, in the bed of which lie exposed bowlders, gravel, fine sedimentary silt, and a coarse highly ferruginous conglomerate, which latter, in decomposing, has imparted much iron to the water. The rocks here have been stained a deep red color. Fossils are noticeable also at the south end of the San Fernando tunnel, which has a length of 7,678 feet. In this cañon a thin seam of lignite has been exposed. The surface of the water where, standing in stagnant pools long, is covered with a scum of oil.

This variety of sandstone underlies the city of Los Angeles, where, from time to time, petroleum in small quantities has been met with. The water obtained in a well being sunk for the soap and chemical works of Mr. E. C. Niedt, at the time I was in that city (May, 1884), was found to be mixed with oil. The sedimentary rocks, as seen at the Temple Street cut, dip 56° S.E. nearly, and strike nearly S.W. At another point they incline 58° to the S.S.E. They strike at right angles with the dip; the stratification being wonderfully regular, with seams of selenite, as at Pico Cañon and Petrolia. At Tunitas Creek, San Mateo County, near the oil wells, the road cuts through a stratum of loose, rounded bowlders, full of fossils—*Pecten pabloensis.* The creek near Lobitas Station has eroded a fine sedimentary silt formation, rich in fossils, and which, extending westward, terminates on the seashore in a bluff seventy-five feet high, where again this same class of organic remains appears.

There is at Moody Gulch, Santa Clara County, nothing in the surface geology to indicate the source of the petroleum found at that place. The formation consists mainly of sand, gravel, and fragments of a soft yellow sandstone, samples of which were taken for the Museum. This sandstone resembles some found on Russian and Telegraph Hills, in San Francisco. I was unable to obtain here any fossil remains, nor could I learn that any had ever been observed by others. On the road below the wells is a cropping of this rock, which here has evidently been much disturbed. In the hill, which rises some two hundred feet above the upper well, the sandstone is found only in broken pieces, though the workmen report a ledge on the other side of the summit. There is here, also, so far as my observation extended, an absence of fossils.

FOSSILS FOUND IN THE CALIFORNIA OIL REGIONS.

The following comprises the fossils observed in the examination of the California oil regions:

At Snow's Well, near Petrolia, Los Angeles County, broken tooth of shark, *Carcharodon* sp.; and (5651), *Lucina borealis*, Lin. Pliocene.

At Sargent's, Santa Clara County, with asphaltum (5650), *Crassatella collina*, Con. Miocene; (5649), *Arca microdonta*, Con. Miocene; and (5647), Tapes stanleyi, Gabb, Pliocene.

Lobitas Station and Bluff, on the seacoast, San Mateo County (5645), *Saxidomus gibbosus*, Gabb, Pliocene; (5649), *Arca microdonta*, Con. Miocene; (5648), *Pecten pabloensis*, Miocene.

Oil wells, Tunitas Creek, same county (5648), *Pecten pabloensis*, Miocene.

The fossils found near Newhall, Los Angeles County, have not yet been determined, though they belong, without much doubt, to the tertiary.

SAMPLES OF OILS AND ASPHALTUM.

Below is given tabular statement of oils and asphaltum gathered and placed in the State Museum:

Catalogue Number.	Specific Gravity.	Description.	Locality.	Township and Range.	Degrees Beaumé.	Proportion of Sand and Impurities.
5633	1.143	Maltha	Tar Creek, near Sargent's, Santa Clara Co.			
5634		Asphaltum	Tar Creek, near Sargent's, Santa Clara Co.			
5635		Asphaltum, refined	Tar Creek, near Sargent's, Santa Clara Co.			
5636		Asphaltum, refined	Tar Creek, near Sargent's, Santa Clara Co.			
5637	1.15	Asphaltum, pure	Tar Creek, near Sargent's, Santa Clara Co.			
5638		Bréa	Petrolia, near Anaheim, Los Angeles Co.	Sec. 5, T. 3 S., R. 9 W.		56.8 per ct.
5639	.969	Maltha	Petrolia, near Anaheim, Los Angeles Co.	Sec. 5, T. 3 S., R. 9 W.	15°	
5640	.920	Maltha	Puente, Los Angeles Co.	Sec. 1, T. 3 S., R. 10 W.	22°	
5641	.795	Petroleum Green Oil	Tunitas Creek, San Mateo Co.	Sec. 25, T. 6 S., R. 5 W.	46°	
5642	.830	Petroleum Green Oil	Pico Cañon, Los Angeles Co.		39°	
5643	.797	Petroleum Refined	Pico Cañon, Los Angeles Co.		46°	
	1.81	Petroleum, in sand	7 miles from Santa Cruz, Santa Cruz Co.			80.2 per ct.

The production of petroleum in California, from 1878 to date, in barrels of 42 gallons, is here given, the yield of the first five years being taken from *Mineral Resources of the United States*, Albert Williams, Washington, 1883:

1878	15,227
1879	19,858
1880	42,399
1881	50,000
1882	70,000
1883 / 1884	190,540
Total	388,024

Cost of oil, 33° to 40° B., to the Los Angeles Electric Light Company, is $2 50 per barrel.

Newhall light refined oil sells for 6 cents per gallon at refinery. At Los Angeles, Puente, and Petrolia, crude oil commands 10 to 25 cents per gallon.

We have been heavy importers of petroleum, home requirements in this line having always been large, while a great extent of outside territory has been supplied from San Francisco.

Receipts at this port from the Eastern States amounted last year to 304,785 cases, besides considerable quantities received overland at interior towns.

The distribution from this point has for many years past ranged from two to four million gallons per annum, the quantity sent out last year having exceeded the latter figure. The annual consumption of California, Oregon, and Washington Territory, may be set down at 4,000,000 gallons, the demand for these countries undergoing rapid enlargement. Our exports of petroleum go mostly to British Columbia, Asia, and Asiatic Russia, with a little to Tahiti, Mexico, South America, and other of our neighbors. We shall probably be able in the course of a year or two more to supply the product of our California wells to not only these countries, including all the islands of the Pacific, but to the entire coast, from Cape Horn to Behring's Strait, and eastward to the Rocky Mountains, nor can we see any reason why we should not in time command the markets of the Orient.

THE OUTLOOK.

Everything considered, the prospects of the petroleum business in California may be pronounced highly encouraging. Having met with some disappointments at first, our people, being then largely engaged in mining for the precious metals, dropped the oil business, and for a number of years gave it little or no attention. Returning to it now, they are embarking in this industry with their usual energy—a guarantee that our petroleum deposits will, after the manner of our gold and silver mines, be worked to their fullest extent.

107. PETZITE. Etym. *Petz*, the chemist who first analyzed it. See, also, Tellurium.

This mineral is a variety of Hessite (which see), being a telluride of silver and gold; the latter metal replacing part of the silver. It is of too rare occurrence in California to have any practical value aside from the gold it contains, and interesting only as being an associate of gold.

An analysis of a specimen from the Stanislaus mine, Calaveras County, afforded Kustel:

Tellurium	35.40
Silver	40.60
Gold	24.80
	100.80

While this analysis shows the mineral to be rich in gold, it is so rare that only very small specimens can be obtained, and these but seldom. It occurs with the other tellurium minerals which constitute but a very small portion of the vein matter.

The following localities are known: Stanislaus and Melones mines in Calaveras County; Morgan mine, Tuolumne County.

108. PHOSGENITE. Etym. *Phosgene*, Light Producer. Chloro-Carbonate of Lead.

A single specimen has been found in quartz from the Silver Sprout mine, western slope of the Sierra Nevada, Inyo County. Straw-colored, acicular interlaced crystals in cavities (Aaron). Determination by C. Ide.

PHOSPHATE OF LIME—see Apatite.

109. PICOTITE. Etym. *Picot de la Peyrouse*, French chemist. Chrome Spinel.

Has been found by Dr. M. E. Wadsworth in the basalts of Mount Shasta; "Summary of the Progress of Mineralogy in 1882"—H. C. Lewis.

PICROLITE—see Serpentine.

PLATINIRIDIUM—see Platinum and Iridium.

110. PLATINUM. Etym. *Plata*, Silver. See, also, Iridium.

Platinum is one of the elements, a metal first found native in the gold sands of the River Pinto, District of Choco, South America, where it was named *platina*, a derivative of *plata* (silver), which it resembles. It was brought to Europe in 1741, at which time it was known as "*platina del Pinto*." The ore (if this is a proper term) was examined by the noted chemists of that day, who soon found it to be composed of a number of new minerals, which are now called the *platinum group*.

Platinum is found generally in placers like gold, usually in grains, plates, or irregular lumps, rarely in octohedrons or cubes. H=4—4, 5; sp. gr.=16—19; luster and streak metallic; color and streak, steel gray; opaque; sometimes magnetic; infusible. Analysis finds it generally to contain as an alloy or mechanical mixture, gold, copper, iron, iridium, rhodium, palladium, osmium, sand, etc.

For a long time platinum was considered to be infusible, but now, by means of the oxyhydrogen blowpipe, it is melted without difficulty into bars weighing 75 pounds, or more. At the intense heat required in this operation, most of the impurities are volatilized, and thus got rid of. Metallic platinum in form suitable for economic use was formerly obtained by forging. To produce pure metallic platinum, the metal was dissolved in nitro-muriatic acid, precipitated by chloride of ammonium, and heated to redness. The spongy platinum thus obtained, was placed in a tube of iron, or brass, and while red hot, compressed by driving down the tube an iron plunger. The mass so obtained was then heated and hammered on an anvil until it became compact and suitable for drawing into wire, or rolling into sheets. An elaborate account of this operation may be found in Ure's Chemical Dictionary, published in 1820, folio 684. Platinum is used in the arts in the form of vessels, crucibles, wire, and foil, in the chemical laboratory for accurate weights and measures, dishes and tanks in which to boil or distill acid, or to make pickles, instead of in copper, the former method, syphons for drawing off hot or corrosive acids, spatulas, and cocks, and with iridium for vents of heavy ordnance, points of lightning rods, etc. The salts of platinum have their uses in chemistry.

Platinum is rather abundant in California with other metals of the group mentioned under the head of Iridium. The miners call it "white gold," and generally believe it to be more valuable than that metal, declining to save it when informed that it can only be sold for two or three dollars per ounce.

Platinum, with iridium and associated metals, is found in considerable quantities in Trinity County. At Hay Fork, a large stream in that county, all the gold found is more or less mixed with the platinum metals; so much so that dealers deduct two dollars per ounce from the price paid elsewhere for gold dust. At North Fork of Trinity River, platinum is found in less quantities, but in larger pieces. One was once offered for sale in Marysville which weighed over two and a half ounces troy.

Although platinum occurs in the river beds, and on the banks of the streams, yet in the so called "hill claims," about half a mile only from the river, no trace of that metal has been found. In lower Trinity, near its junction with the Klamath, platinum abounds in very fine particles; and it is with this finely divided platinum that Professor Wöhler discovered diamonds.

The metal is so abundant that the miners have the utmost difficulty in separating it from the gold. The particles are so extremely fine that they can hardly be distinguished from the black sand which accompanies the gold. Heretofore no effort has been made to place the platinum in the market, except the sending to San Francisco of 100 ounces or more, a few years ago. It could, probably, be sent to Europe to advantage. In Salmon River it is also found. In fact, it is common in the beds of the streams in Sierra, Trinity, Klamath, and Del Norte Counties.

Platinum (1521) is found with iridium, cinnabar, zircons, and gold, in Anderson Valley, Navarro River, Mendocino County; at Gopher and Badger Hills, Plumas County (Edman).

(1892) with platiniridium. In a claim three miles from Trinity Center, Trinity County; and with gold, zircons, diamonds, and other minerals from Cape Blanco to Cape Mendocino, on the ocean beach.

Mr. A. Hewett found several large pieces of platinum in 1851 on Nelson Creek, Plumas County. The largest was the size of a large bean.

Mr. Block, of San Francisco, said that large pieces have been found on North Fork of Trinity River; one piece weighed two ounces. The miners in washing gold in long sluices got the gold by the aid of quicksilver, and the platinum minerals remained in the riffles.

Platinum is found rather abundantly in Butte County. Considerable quantities were recovered in the clean-ups at the Spring Valley hydraulic mine, Cherokee, and at St. Clair Flat, near Pence, large quantities were found in the early days of placer mining.

If the miners could be persuaded to collect the platinum minerals, an industry might be established of considerable importance. There is no reason why platinum should not be manufactured in San Francisco and the American demand in part or wholly supplied by this State. The process of manufacture is simple, the plant required inexpensive, and there are skillful chemists in the State fully competent to manage it. The control of the platinum trade is in the hands of a single English manufacturing firm, which has been the case for many years.

Platinum is largely produced in Russia. The following is an official table of the production. (1 poud equals 526.64 troy ounces; 1 livre, 13.166 troy ounces; 1 zolotnick, 1,364 troy ounces):

Years.	Pouds.	Livres.	Zolotnicks.	Years.	Pouds.	Livres.	Zolotnicks.
1867	109	9	56	1872	94	39	68
1868	122	23	47	1873	96	9	85
1869	142	39	91	1874	122	39	42
1870	118	38	33	1875	94	7	44
1871	125	6	56	1876	96	8	48

111. POLYBASITE. Named from the Greek—*Many Bases*—it being a sulphide of many bases, viz.: antimony, arsenic, copper, iron, silver, and zinc.

It is a rare mineral in California, being found only in small microscopical crystals in the Morning Star and Monitor mines, Alpine County.

112. PRICEITE. Etym. *Price*, San Francisco chemist.

In October, 1871, Lieutenant A. W. Chase brought to the Academy of Sciences of San Francisco a sample of chalky substance, which he thought to be magnesia. A small sample was given to me for examination, which I turned over to a pupil, Mr. E. J. Shipman, who spent some time over it, and reported it to be borate of lime. Never having seen borate of lime in this form, I requested him to repeat his experiments, which he did, and with the same result. I then made an examination of the mineral myself, both chemical and microscopical, which led me to class it with *cryptomorphite*. The appearance under the microscope was so characteristic that I had no doubt as to its identity. At the evening meeting, November sixth, Lieutenant Chase presented it to the Academy of Sciences. Subsequently two samples were analyzed by Thomas Price, of San Francisco, which gave the following result:

	1.	2.
Boracic acid	47.04	45.20
Lime	29.96	29.80
Water	22.75	25.00
Alkalies	.25	Traces.
	100.00	100.00

In 1873, Professor Silliman made a study of this mineral, and obtained the following mean of three analyses:

Boracic acid	49.00
Lime	31.83
Water	18.29
Alumina, salt, and oxide of iron	.96
	100.08

The absence of soda separates this mineral from ulexite and cryptomorphite, and seems to make it a new species, named as above by Professor Silliman. After studying this mineral and examining many specimens, I am led to believe that it is changed from ulexite by the abstraction of the soda and part of the water. I have a specimen of pandermite, which has undoubtedly changed from a ulexite "cotton ball."

PANDERMITE

Is a variety of priceite. The following extract from the London *Journal of the Society of Arts*, August 6, 1880, by C. C. Warnford Lock, affords all that is known relating to this mineral:

I have now to deal with a new commercial borate, which, on the score of geographical position, abundance, cheapness of working, and easy manipulation, is certainly destined in a great measure to rule the markets of Europe, and particularly of Great Britain.

The new field lies on the Tchinar-Sau, a small stream feeding the Rhyndacus River, whose outlet is in the Sea of Marmora, near the port of Panderma, on the Asiatic shore. It embraces the villages of Sultan-Tchair, Yildiz, and Omerli, and the guard-house of the Demircapon pass. The area of the field is computed at over 13,000 acres (20 square miles). Its eastern confines nearly abut upon the Rhyndacus, which has been navigated by steamers up to a point called Balakeser. A company has been formed for deepening and improving the stream, and a railway has been projected from Panderma to Balakeser. The wagon road has hitherto been utilized for transporting the mineral, the distance from Panderma to the western edge of the field being about forty English miles. The port of Panderma is regularly frequented by local steamers, and offers every convenience for shipping.

The field is situated in a basin of tertiary age, surrounded by volcanic rocks, which vary from granite on the east to trachyte on the north, and columnar basalt on the west. Several basaltic hills and dikes protrude in different portions of the basin, and the presence of hot and mineral springs further testifies to the volcanic influences which have been at work, and in which, doubtless, originated the boracic mineral. The latter occurs in a stratum at the bottom of an enormous bed of gypsum, its greater specific gravity probably impelling it downwards while the whole mass was yet in a soft state. Several feet of clay cover the gypsum bed, which is here 60 to 70 feet thick, though in places it attains to double that thickness.

The boraciferous stratum varies in depth; it has been proved for a vertical distance of forty-five feet. The mineral exists in closely-packed nodules, of very irregular size and shape, and of all weights up to a ton. Vom Rath has named it "Pandermite," from the port of shipment.

In outward appearance it closely resembles a snow-white, fine-grained marble. Chemically speaking, it is a hydrous borate of lime, its composition being expressed by the formula $2CaO, 3B_2O_3, 3H_2O$; in other words, it consists of boracic acid 55.85 per cent; lime, 29.78 per cent, and water 14.36 per cent. Its richness in boracic acid is at once apparent, and places it high above the other commercial borates. Thus ordinary borax (borate of soda) contains only 36.58 per cent of the acid; boro-calcite and boronatro-calcite (borates of lime and of lime and soda) vary from 8½ per cent up to 46 per cent, and average about 40 per cent, boracite and stassfurtite (borates of magnesia), containing respectively about 63 per cent and 60¾ per cent, alone surpass it in this respect, and they can hardly be deemed commercial minerals. After very simple preparation pandermite can be very directly applied as a flux, and is more economical than borax for this purpose, thanks to its larger proportion of boracic acid.

An outcrop of the mineral was discovered by a foreigner some years since, and the bed was secretly worked; small shipments were occasionally made to Europe under the denomination of plaster of Paris, thus keeping the matter hidden, and at the same time avoiding the payment of dues and duties. The Ottoman Government has since been apprised of these irregularities and has taken energetic measures to correct them. More recently it has granted a comprehensive concession to a party of British residents, who are setting to work to develop the property. The district enjoys the great advantage of being under British protection.

The workings were at first placed under that section of the Réglement des Mines relating to quarries, but have since been transferred to the section regulating mines proper. Steps are being taken to open up the deposit in a systematic manner, by first sinking a number of bore-holes—as has been done with the Kainit beds at Stassfurt—to ascertain the points of greatest development in the basin. The locality possesses a healthy climate, except in the Autumn, when there is some ague.

Labor is very cheap and abundant, Turks, Armenians, Greeks, Circassians, Tartars, and Italians being obtainable from the neighboring villages. There is a supply of water; oak and fir timber may be procured at six to seven miles distant, and scrub for fuel covers the surrounding hills.

The actual cost of the mineral, as now worked, is as follows:

Raising and dressing (exclusive of cost of tools)	10.0 paras per oke
Transport to Panderma	9.0 paras per oke
Custom duty, 1 per cent ad valorem	.5 paras per oke
Management and other charges	2.5 paras per oke
Total	22.0 paras per oke

	£	s.	d.	
At 795⅗ okes per ton, and 128¼ piastres per £ sterling (1 piastre=40 paras) this will equal	3	8	3	per ton
To this must be added the government royalty, 5 per cent ad valorem, say	0	5	0	per ton
Contingencies	0	10	0	per ton
Freight and insurance	0	15	0	per ton
Making a total cost, "c., f., and i."	£4	18	3	per ton

The present values of the boracic products now in the market vary from £46 to £60 per ton, according to quality; the lowest figure ever reached here has been about £20 a ton, at which price the demand would immensely increase.

Pisani, of Paris, analyzed this mineral and obtained the following result:

Boracic acid	50.1
Lime	32.0
Water	17.9
	100.00

It will be seen as stated elsewhere that the variety pandermite has recently been found in apparent abundance in Death Valley, Inyo County, and at Calico, San Bernardino County, and the cryptomorphic variety also at the latter locality.

COLEMANITE

Is also a variety of priceite found recently in Death Valley. The following analysis was made by Thomas Price, of San Francisco, March, 1883, by whom the original priceite was first analyzed:

Anhydrous boracic acid	48.12
Lime	28.43
Water	22.20
Alumina and oxide of iron	.60
Silica	.65
	100.00

In the above analysis, the alumina, iron, and silica are probably mechanical impurities—1.25 being added proportionately to the other constituents, gives the following percentage:

Boracic acid	48.72
Lime	28.79
Water	22.49
	100.00

This gives the approximate formula, $4Bo_3$, 3CaO, 6HO, being the same obtained by Silliman for priceite, which no doubt it is in a crystalline state. As this mineral possesses certain physical properties differing from priceite, a name has been given to it to distinguish it from the soft chalky mineral found both in southern Oregon and San Bernardino County, California.

The name *colemanite* was given by the discoverer of the mineral in honor of William T. Coleman, of San Francisco, who has been identified with the borax interests of the Pacific Coast from the commencement.

PROPERTIES OF COLEMANITE.

Color and streak white; milky to transparent; hardness 3.5—4; specific gravity, 2.39; before the blowpipe, it exfoliates, decrepitates violently, and melts imperfectly; after considerable heating it imparts a reddish yellow color to the flame, which changes to green. The mineral pulverizes easily, fragments obscurely rhombic. It is wholly soluble in hydrochloric acid with heat. From the solution boracic acid crystallizes on cooling. The filtrate gives a white precipitate with ammonia and oxalate of ammonia. With sulphuric acid, or with fluorspar and bisulphate of potash, tinges the blowpipe flame green. Luster of the mineral vitreous to adamantine. It shows no perfect crystals, but appears like semi-crystalline calcite.

The above is copied from the third annual report. Since it was published, colemanite has been found in magnificent crystals. In experiments made in my laboratory, it was found to be wholly soluble in dilute hydrochloric acid without effervescence. By a practical test, 30.4 per cent of anhydrous boracic acid was obtained from the first crystallization. The crystals of colemanite are monoclinic, and so strongly resemble those of datholite, that Professor G. Vom Rath, of the University of Bonn, who was in San Francisco when the first crystallized specimens came to hand, expressed surprise at the great similarity. He will study the crystallography carefully on his return to Germany, and will publish figures.

113. PROUSTITE. Etym. *Proust*, French chemist. Light Ruby Silver Ore.

Arsenical sulphide of silver, found sparingly in the Chicago mine, Shasta County, with galena, pyrite, and quartz, between walls of granite (Aaron). No. 4951, in the State Museum, from the Oro mine, Bodie, Mono County, shows it in crystals, with pyrargyrite in quartz.

114. PSILOMELANE. Etym. *Bare* and *Black* (Greek).

A hard black mineral, supposed to be psilomelane, is found in several localities in the State, with pyrolusite and rhodonite, but no analysis has been made to prove it. This mineral differs from pyrolusite in containing baryta and oxide of manganese, and more water. It has been found at Spanish Ranch, Plumas County, on Red Rock, Bay of San Francisco, and in quartz, Santa Ana River, Los Angeles County. No. 1671, in the State Museum, was mistaken for tin ore.

Pumice Stone—see Orthoclase.

115. PYRARGYRITE. Etym. *Fire Silver* (Greek). Dark Ruby Silver, Antimonial Sulphide of Silver.

This mineral, like proustite, is rare in California. It has been found in the Exchequer mine, Alpine County, and with proustite, No. 2451, State Museum, in the Oro mine, Bodie, Mono County.

116. PYROLUSITE. Etym. *Fire-wash* (Greek). Binoxide of Manganese.

Color and streak, black. H=2—5.5. Sp. gr. 4.82. Brittle. Opaque. Composition ($Mn\ O_2$).

Manganese	63.3
Oxygen	36.7
	100.0

B. B. infusible. Non-magnetic.

May be readily distinguished. If pulverized in an agate mortar and wet with hydrochloric acid, chlorine is set free, which can be recognized by its suffocating smell, an odor different from that of the acid alone. If heated in a closed tube oxygen is given off, and if a match is lighted and blown out the live coal at the end of the match brightens and scintillates, if held near the mouth of the tube (oxygen). A small portion of the pulverized mineral imparts to borax an amethyst color, if heated B. B. in loop of platinum wire. This very important and valuable mineral is found in great abundance in California at numerous localities. Its uses may be enumerated as follows: In the production of chlorine gas, extensively used in the manufacture of chloride of lime (bleaching powder); in extracting gold from roasted auriferous pyrites; and as a disinfectant; for the production of oxygen gas; and largely in ferro-manganese, essential in the manufacture of steel and soft iron by the Bessemer process. It will be seen that it contains no chlorine. Still this gas is nearly always set free by its use, at the expense of the hydrochloric acid or salt (chloride of sodium) employed with it. The second equivalent of oxygen in the mineral has but a feeble affinity, and leaves it when heated, as in the experiment with the closed tube and match, leaving behind oxide of manganese ($Mn\ O$). It also passes to any element for which it has a greater affinity, as for example, to the hydrogen of the hydrochloric acid in the first experiment, setting the chlorine free. When salt is used, sulphuric acid is employed; these reactions will be understood by studying the following equations:

1. $Mn\ O_2$ strongly heated$=Mn\ O+O$.
2. $Mn\ O_2+HCl=Mn\ O+HO+Cl$.
3. $Mn\ O_2+Na\ Cl+SO_3=Mn\ O+NaO\ SO_3+Cl$.

Ferro-manganese is made by heating from 30 to 60 pounds of a mixture of pyrolusite, charcoal, and finely divided scrap iron, to a white heat, in crucibles. The alloys contain from 66 to 80 per cent of manganese. When the projected iron works are built (see Iron), pyrolusite will come into demand and be utilized. It has been employed for years in the chlorination process before mentioned, and some has been shipped to England and the Eastern States. The word pyrolusite, meaning *fire wash*, is given from its being used to remove objectionable colors from glass in its manufacture. It is called by the French, for the same reason, "*savon des verriers*" (glass-makers' soap). The known California localities are:

Alameda County. No. 4900, State Museum.

Calaveras County, near Angel's. No. 1170. Railroad Flat, No. 5053.

Contra Costa County. Corral Hollow—abundant.

Marin County. Near Saucelito, and near Tomales.

Napa County. St. Helena Mountain. No. 4337.

Nevada County. Sweetland.

Plumas County. Argentine and Mumford's Hill (Edman).

San Bernardino County. With rhodonite, near Colton.

San Francisco Bay. Red Rock. San Francisco County. Bernal Heights, San Francisco.

Santa Clara County. Hahn's ranch, 12 miles south of the Guadalupe quicksilver mine. No. 4965.

Sonoma County. Near Cloverdale. Nos. 3772, 5107, State Museum. Santa Rosa. No. 2337.

Tuolumne County. Knight's ranch, near Columbia, in botryoidal and mammillary masses, from the size of a grape to 100 pounds in weight, on the surface of the ground. No. 4124. With rhodonite two miles south of Summerville. No. 3657.

117. PHYRRHOTITE. Etym. *Reddish* (Greek). Magnetic Pyrites.

Found in Mariposa County, at the Iona Copper Company's tunnel, north side of the Merced River, on the trail from Bear Valley to Coulterville (Blake).

118. PYRITES. Etym. *Fire* (Greek). Pyrite, Sulphuret of Iron, the "Sulphurets" of the gold miner, Mundic, Martial Pyrites. See, also, Marcasite.

Color, pale brass-yellow, streak greenish, or brownish black. H=6—6.5. Strikes fire with steel, whence the name; opaque, fracture conchoidal, brittle. Composition ($Fe\ S_2$).

Sulphur	53.3
Iron	46.7
	100.0

In closed tube gives sulphur as a yellow sublimate above the assay, and a magnetic residue. If pulverized and thrown on hot coals, or red-hot iron, it gives off fumes of sulphurous acid, smelling like a burning match. It generally contains gold, and in California is seldom wanting in auriferous quartz, except in oxidized ores lying above the water line, in which case the crystals of pyrite are changed to limonite, often specked with gold. In some mines, nearly all the gold is in the sulphurets, and is sometimes obtained after mechanical concentrations, by the "chlorination process." The ore is first roasted in a reverberatory furnace, always letting the sulphur go to waste. It is then dampened with water and placed in a large wooden tub with perforated false bottom, upon which coarse cloth is laid. Chlorine gas is generated (see Pyrolusite), and conducted in a lead pipe to the bottom of the tub below the false bottom, until the mass is saturated with the gas, after which it is closely covered, and allowed to stand for several days. It is then leached with cold water, sprinkled over the surface by a hose. After some time, a greenish-yellow fluid begins to flow from a small aperture at the bottom of the tub, which is carefully collected in glass vessels, generally boxed carboys. This fluid contains the gold. The sprinkling is continued until the water flows off colorless, and gives no reaction for gold when treated as described below. Solution of proto-sulphate of iron is added to the contents of the carboys, with frequent shaking, as long as a black precipitate falls. After standing for a time, the liquid and precipitate are decanted on paper filters in glass funnels; the worthless liquid filters through, leaving the gold precipitate on the paper. The filters are dried and rolled up into wads, or balls, and placed in succession in a crucible, kept in a high heat in a bullion furnace. Fluxes are added from time to time, until the gold is melted, when it is poured into an iron ingot mold in the usual manner. This process, so extensively practiced in the State, has been found to be wasteful and unsatisfactory, and will, no doubt, eventually be replaced by one in which the sulphur and iron will be saved, and also more of the gold. This subject has been mentioned elsewhere in this report, and is one of great importance. Pyrite is one of the most abundant of the minerals of the State, and is represented in the State Museum by many localities. The specimens are so numerous that it is hardly worth while to mention them all here. Auriferous sulphurets often contain barite, bornite, calcite, cinnabar, chalcosite, chalcopyrite, native copper, enargite, fluorite, galena, marcasite, mispickel, molybdenite, quartz, roscoelite, silver minerals, siderite, sphalerite, stromeyite, tellurium, and other minerals. The gold quartz worked in California contain from one to five per cent of sulphurets; when concentrated, they assay from one hundred to three hundred dollars per ton, although the gold saved in the mill might not have exceeded from six to ten dollars per ton. A very interesting table of analyses, from different mines, may be found in Dr. Trask's report for 1856, folio 60. The table shows that the loss was very great at that time. Pyrite is often mistaken for gold by inexperienced prospectors. In 1847, the ship "Brooklyn," of New London, Captain Carroll, was whaling in Magdalena Bay, Lower California. The crew discovered what they thought to be gold in vast quantities. Several ten barrel pipes were filled with pyrites, and the men stopped catching whales, and sailed away for New London with a supposed fortune for the owners and all on board. Of the numerous localities of pyrite in the State, the following are worthy of special mention, or are represented in the State Museum:

Alpine County. Morning Star mine, with enargite.

Amador County. Jackson, No. 653.

Calaveras County. E Pluribus Unum mine, three miles from Murphy's (Blake).

El Dorado County. Brilliant cubes, Mameluke mine, near Georgetown (Blake). Pilot Hill, in large cubes, with garnet-brown spar and specular iron (Blake). In crystals with gold (3701), with quartz, both crystallized.

Inyo County. Modoc mine (1649).

Mariposa County. In slates, in large and perfect crystals, near Princeton Hill (Blake).

Mono County. No. 2128.

Napa County. With cinnabar, Redington quicksilver mine, No.

1505, very fine. In cavities in quartz, cubical crystals, Knox & Osborn quicksilver mine, No. 4338.

Nevada County. Grass Valley, massive, with chalcopyrite, San Francisco copper mine, Spenceville, No. 4386. Massive, with gold, Meadow Lake District, No. 4357. Taking the form of wood, with hematite, Occidental mine, Scott's Flat, No. 1515. With calcite, Malakoff mine, North Bloomfield, No. 3394. In lignite, Malakoff mine, North Bloomfield, No. 3411.

Placer County. Globular, in calcite, near Auburn, No. 3671. Clipper coal mine, No. 4905, near Grizzly Bear House, Forest Hill, in large crystals (Blake). True Fissure mine, Devil's Peak Mountain, No. 2916. With lignite, Spink's coal mine, Lincoln, No. 981.

Plumas County. Granite Basin, Mumford's Hill, in crystals, with dolomite (Edman).

San Luis Obispo County. In cavities in the Sunderland quicksilver mine, No. 2348.

Shasta County. With pyrolusite and gold, Banghart mine, No. 1794. With erubescite and chalcopyrite, Copper City. In nodules, with sulphide of silver, very rich, Nos. 1710, 1711, 4140.

Tuolumne County. In fine crystals, Patterson mine, Tuttletown.

119. PYROPHYLLITE. Etym. *Fire Leaf* (Greek).

This mineral, a hydrous silicate having no economic value, but which is interesting from a scientific standpoint, is found in beautiful radiating tufts of a golden yellow color, at Greaser Gulch, or Indian Gulch, Mariposa County. It occurs in large bowlders on the surface of the ground, near two prominent buttes. This locality is represented by No. 3723 in the State Museum.

120. PYROXENE. Etym. *Stranger to Fire* (Greek).

A silicate of different bases, the varieties of which are known under different names, as augite, diopside, sahlite, omphazite, hypersthene, diallage, smaragdite, etc.

This mineral enters largely into the composition of igneous rocks. In this form it is probably largely distributed in California. It is found in fine dark green crystals near Mud Springs, El Dorado County (Blake), and also in fine crystals at the Cosumnes copper mine, in the same county.

121. QUARTZ.

Quartz is one of the most abundant minerals of the earth's crust, being found in the crystalline or primitive rocks, and in all the sedimentary ones resulting from their disintegration and decomposition. It assumes many forms and colors, from opaque quartzite to the purest rock crystal, superior to glass for optical purposes; from black to snow-white, amethyst, or rose color. The varieties are known by many names, among which are agate, amethyst, aventurine, blood stone, Brazilian pebble, buhr stone, carnelian, cat's-eye, chrysoprase, cairngorm, false topaz, heliotrope, jasper, mocha stone, onyx, prase, quartz and quartzite, rock crystal, siderite, sardonyx, etc.

Quartz is colorless when pure, otherwise blue, green, brown, red, yellow, black, and variegated; fracture conchoidal, brittle, crystals often inclosing impurities and foreign crystals, as chlorite, cinnabar, titanic acid, etc. When massive, often a matrix for gold, silver, galena, zinc blende, magnetite, and other minerals. Quartz is the principal vein matter of our best mines. Sp. gr. 2.5 to 2.8 H. 7; scratches glass easily, but is scratched by topaz. All varieties have nearly the same chemical composition and physical properties; the clear colorless crystals of quartz are often mistaken for diamonds. The fact that they are softer than topaz will serve to distinguish them from that gem. The color of the different varieties is owing to the accidental presence of the oxides of different metals.

The principal constituent of all these varieties is silica, or silex in its insoluble form; that is, not soluble in caustic soda solution. Before the blowpipe alone they undergo no change, but with soda dissolve with effervescence and form a transparent glass. Insoluble in acids. If previously fused with carbonate of potash and soda, they become soluble in hydrochloric acid.

Quartz is a binoxide of silicon ($Si\ O_2$), the elements being combined as follows:

Silicon	46.67
Oxygen	53.33
	100.00

Agate is a variety of chalcedony, generally in layers, sometimes clouded. Moss agate is chalcedony with dendritic crystals of oxide of manganese and iron imbedded in it, which take the form of vegetation. The ancient "achates" was probably fortification agate. Pyrrhus, who lived 318 years before Christ, is said to have had an agate of this kind, on which was represented, by the hand of nature, a picture of the Nine Muses as perfect as a work of art. Achates, from which agate was named, was an ancient town in Sicily. The moss agate was known to the ancients as dendracthates (dendritic agate).

AMETHYST

Is a purple red variety of quartz crystal, formerly supposed to owe its color to oxide of manganese, but specimens having been analyzed which contained no manganese, the color is now thought to be due to some peculiar compound of iron or soda. Rose quartz is a variety of amethyst only slightly tinged.

The amethyst was well known to the ancients and was highly prized by them. They gave this gem the name of "aphrodisiace," or gem of Venus. By some strange superstition they believed the amethyst to be a cure for drunkenness, from which the name is derived. A good well-cut amethyst of one carat is worth from three to five dollars. A large and fine stone of good color has been sold as high as five hundred dollars. The best amethysts come from Ceylon, Brazil, and Siberia. Good specimens are found on the shores of Lake Superior, in the quartz formation of the Comstock ledge, and at Grass Valley. The true amethyst must not be confounded with the violet sapphire, sometimes called oriental amethyst, which is much more valuable and of entirely different composition.

Aventurine is quartz, massive, of a pearly or reddish color, and containing thin plates or scales of mica, which give it a peculiar glimmering appearance, much admired in cut specimens. It is found in India, Bohemia, on the shores of the White Sea, and elsewhere. The best specimens come from Cape Gata, in Spain. The artificial aventurine is far more beautiful than the natural. A formula for making it is as follows: Heat together, for a long time, eight parts of ground glass, one part of protoxide of copper, and two of oxide of iron, and allow the mixture to cool slowly. An artificial production, said to come from Japan, is extremely puzzling. In cutting a thin section and examining it under the microscope, the spangles are seen to be perfect tabular crystals. Mrs. Captain Nathan, of San Francisco, has a magnificent specimen of this singular production.

The finest specimens of natural aventurine known, are two large vases cut from this rare mineral, which were presented by the Emperor of Russia to Sir Roderick Murchison. They are now in the Museum of Economic Geology, of London.

Bloodstone and heliotrope are names for the same variety. The color is deep green interspersed with spots of red, like drops of blood. Good specimens command as high as twenty dollars each. Heliotrope takes its name from having been used under water as a mirror to observe a solar eclipse. Pliny describes the heliotrope as being "prasius" which was "horrid with spots of blood."

Brazilian pebble is quartz crystal, or massive rock crystal, rolled and water-worn; was first brought from Brazil. It is very valuable for making glasses for spectacles, being harder and more durable than glass. A good deposit of this mineral would be very valuable. The Japanese excel in cutting quartz or crystal.

There is a locality near Placerville where this valuable mineral is found, and which should be examined with a view to supply the market. Good clear pieces would find a ready sale in London or Paris.

No. 5931, in the State Museum, is a magnificent specimen of Japanese rock crystal, in the form of a sphere, two and a half inches in diameter. Sent by the Government of Japan in exchange for California minerals.

BUHR MILLSTONE.

"*Bur*"—old English for a whetstone.

This valuable mineral has been found at several localities in the State; one examined by the State Mineralogist a number of years ago, is a small outlier in Owen's River Valley, Inyo County, known as "Little Butte," which is a prominent landmark on the line dividing Russ from Inyo mining districts. It lies partly on section thirteen, township thirteen south, and range thirty-five east, and partly on section eighteen, same township, range thirty-six east. The stone is hard and brecciated, somewhat resembling the celebrated French buhr stone. A sample has been placed in the State Museum, No. 2189. Dr. J. B. Trask, first State Geologist of California, says in his first report, that it is found in great abundance on Pit River—in Modoc County—extending to the north of Goose Lake. The following quotation shows what importance he attached to the discovery:

> Its admirable adaptation to milling requires no comment. The value of this rock cannot be too highly esteemed in this State, where the prospective is so flattering of its becoming a grain-growing country equaled by few on the Atlantic slope. The heavy expenses that are now incurred, and the future wants of the State in this particular, will be obviated, and our dependent condition on foreign import destroyed. These rocks have as yet attracted little notice, bnt the rapidly increasing wants of the State will ere long bring them into requisition.

Most of the buhr stones heretofore used in the United States have been imported from France, Belgium, and Germany, whence they are brought in a partially dressed state. Some have also been quarried in New York and Pennsylvania. As metallic rollers are being largely substituted for buhr stones, the importance of the latter is likely to diminish in the future.

Carnelian is a clear bright red chalcedony. It takes its color from oxide of iron. Fine specimens come from Lake Superior. The first specimens found their way to us from Siberia, India, Arabia, Nubia, and the Tyrol.

Carnelian is sometimes diversified by stripes of white, and can be cut into beautiful jewelry. It does not command a high price, but good specimens find a ready sale. The sardonyx is a variety of carnelian, with stripes of white, of a thickness to admit of cutting into cameos. That is to say, by cutting away portions of the red, and leaving figures of red on a white base, or the reverse. A good sardonyx commands a high price.

Sardonyx.—The name sardonyx was the same anciently as now. It is the onyx in which some of the bands are carnelian. The first historical record of the use of this stone as a seal is the case of Scipio Africanus, from whose time it was much used, as it was found that the wax did not stick to it.

The ancient name for carnelian was "sard," because it was found at Sardes, an ancient town in Asia Minor, on the banks of the Pactolus. It was afterwards found near Babylon.

The name is derived from *carneus*, flesh, which it was supposed to resemble.

Chalcedony generally takes a mammillary or botryoidal form, often constituting a smooth lining of cavities. It is formed by a gradual deposit from water holding silica in solution. It takes its color accidentally from the substances it is thrown in contact with. The most beautiful color is a delicate pink, which is quite common at Aurora, Esmeralda County, Nevada. Chalcedony is named from Chalcedon, an ancient city in Bithynia, in Asia Minor. This mineral is also found in many beautiful forms at Volcano, Amador County; in Monterey County, near Panoches; on Walker River, Nevada; between Williamson Pass and Johnson's River, Los Angeles County, and in many localities in other parts of the world.

Cat's-eye is a translucent variety of quartz, which, when cut, presents a peculiar appearance, supposed to resemble the eye of a cat, whence its name. This peculiarity is owing to its being intersected by filaments of asbestos. Cat's-eye is found in small fragments in Ceylon, never in pieces larger than a hazlenut. Common varieties are sold for $20 or thereabout, while the best specimens command $100. "Beli oculus" was the ancient name for cat's-eye.

Prase and Chrysoprase always occur massive. The latter is of an apple or leek green color, which it takes from a portion of nickel it contains. It is translucent; luster, vitreous. It loses its color when heated. It is composed of silica, carbonate of lime, alumina, oxide of iron, and nickel. A good chrysoprase suitable for a ring is worth from $25 to $30. A remarkably fine specimen has been sold as high as $60.

The chrysoprase of the ancients resembled in color the juice of the leek, a golden color, whence its name.

Smoky quartz is known in commerce as cairngorm, from a celebrated locality in the Cairngorm Mountains in Scotland. It is common in California. The best I have seen came from near Placerville.

FALSE TOPAZ

Is a clear yellow variety of crystallized quartz. It resembles yellow topaz when cut, but may be distinguished by its hardness, which is less than that of true topaz, and by its specific gravity. Beautiful specimens are found occasionally on the Comstock, near Gold Hill, Nevada.

Jasper is always opaque and of a dull color. It is sometimes striped or clouded. It has a low value, but some varieties are very beautiful when cut and polished. It sometimes occurs in very large masses; luster sometimes resinous or like wax.

It scratches glass, but is scratched by a quartz crystal. Some very fine varieties of jasper occur near San Francisco. Jasper is always a metamorphic rock. It is generally the result of the action of heat on sandstone, which has been so changed as to lose the character of sand and become somewhat homogeneous. There is a specimen in the collection at the University of California from Knight's Ferry, showing the sandstone, one side of which has been changed to jasper. A fine variety of jasper is found near Murphy's Camp. It is of a brown color and beautifully variegated. Jasper under the name of "iaspis" was a favorite stone with the ancients.

Red and green jasper are common on the peninsula of San Francisco. Several hills in the southwestern part of the city consist mainly of jasper, slightly mixed with clay, etc. This rock is tolerably hard, and by reason of the facility with which it can be obtained, has for many years past been largely used in and about the city as a bedding for sidewalks, park paths, for filling between basalt blocks and cobble stones, and similar purposes, still more having been employed for paving suburban and little traveled streets, this material not answering well for those much used by heavily laden vehicles. In removing this rock extensive pits, or rather terraces, have been excavated from the sides of these hills, a perpendicular face nearly 100 feet high having been worked on some of them. After being broken out with pick and powder the rock is carted to the edge of the terrace and sent down through chutes into large bunkers fifty or sixty feet below, the smaller particles being separated from the larger by a screen in the bottom of the chute. From the bunkers it is hauled directly to the places where used, the coarser rock being placed below, and the finer on top, and, in the case of sidewalks, covered with asphaltum or concrete, this being necessary to make them sufficiently smooth. The passage of teams grinds up this material, which, if kept a little moist, impacts and makes a clean solid pavement. During the past few years of active improvement in the city, large excavations have been worked into the sides of these jasper hills, as many as 200 men having sometimes been employed getting out and carting away this rock, of which there is enough to last for all time to come. To call these pits mines, or this rock a concrete, as is sometimes done, is a misnomer, the former being nothing but open quarries, and the latter simply a crumbly sort of rock mixed with a little clay, but possessing none of the properties that distinguish a concrete.

Mocha-stone is quartz in which is imbedded irregular particles of the oxides of iron and manganese, different from the moss agate before described. It is found in Arabia, and is supposed to take its name from Mocha. Some very peculiar and beautiful specimens have lately been brought to San Francisco from the Aleutian islands.

Onyx is a variety of agate, in which stripes of white and black alternate. This stone is used in cutting cameos, the white portion being cut away so as to leave white figures on a black ground.

Quartzite is a rock consisting of impure massive quartz. Generally granular and often schistose, it is considered to be a mica schist, very poor in mica; or metamorphic sandstone. It is found in California in many forms and colors.

Siderite is Berlin blue quartz. It comes from Salzberg.

Quartz is too soft to rank high as a gem, but some of the varieties are held in esteem. It is not generally known that a fine amethyst soon becomes dull and almost lusterless if not often cleaned with soap and water. It is a good rule to wash such a stone frequently, with a small brush, and then to wipe it dry with a towel. The more noble gems do not require so much attention, but even they may sometimes be so improved.

QUARTZ JEWELRY.

Gold-quartz jewelry has become very common since the discovery of gold in California, so much so as to attract but little attention; although when first introduced it was much admired. It was difficult to obtain pieces suitable for this purpose while the demand continued. A magnificent specimen of this work was shown at the Paris Exposition of 1878. It was designed by A. Andrews for Mrs. M. A. Sunderland, both of San Francisco. All the work was done by San Francisco artists and artisans. It was exhibited in the United States section. The following description, in French and English, was printed in pamphlet form, and distributed by Mr. Thos. B. Oakley, of Paris:

From the private collection of Mrs. M. A. Sunderland, of San Francisco, California, United States of America.

These three works of art were made expressly for the Exposition in Paris, 1878, by order of this lady, the work having been executed by a jeweler of San Francisco.

The first is a *massive and elegant porte-monnaie and card-case combined*, made of solid gold, and the quartz rock beautifully designed in mosaic, interspersed with gold. The quartz rock comes from the mines of the States of California, Nevada, Arizona, and Washington Territory.

The second is a ladies' powder-box and puff, a very exquisite work of art and taste. This powder-box is composed of quartz rock from all the leading mines of California, Idaho, and Oregon; its shape being round, and made to resemble a Greek dome, the top or cover being supported by eight columns of solid gold quartz rock, beautifully polished, each capped with pure gold.

The cover forming the roof of the dome is exquisitely inlaid with quartz rock of variegated colors, filled with the precious metal, and is bound on edge with a solid rim of gold, the inside being lined with solid gold. The body of the box is made from one large mass of quartz rock, bored out and elegantly polished on the outside, while the inside is lined throughout with solid gold, and rests on an ornamented base made of quartz rock mounted in gold.

The whole is surmounted with the emblem of California, viz., the grizzly bear, who is represented as crossing the great overland railway.

The powder-puff is made of the same material, and is of the greatest taste. Two pounds of solid gold and the same quantity of gold quartz were required to make the above.

The third is the most rare and beautiful jewel casket in the world. This casket, representing the substantial wealth of the mines on the Pacific Coast, is made entirely of gold and gold quartz rock from the mines of California, Oregon, and Idaho, and required the steady work of five of the most skillful artisans for six months for its completion. It is about 15 inches long, 10 inches wide, and 12 inches deep. For richness of beauty and novelty it has never been surpassed, not even by the celebrated damascened casket of the sixteenth century, made at Venice by the artisans "Azzuminsti." It rests on four feet of solid gold, each of which represent the symbolic female figure that adorns the coat of arms of the State of California, with the bear by her side. The figures are in full relief and most elegantly formed, and constitute a salient feature of the beautiful work. The sides and ends of the casket are composed of solid slabs of gold quartz, highly polished, cut in spheroids, and are inlaid in solid gold with ornamental surroundings. The four handsomely wrought pillars are of Roman-Doric style, which is artistically carried out in the entire work. The base of the casket is ornamented with graceful foliations which are repeated upon the moldings that finish the lid or cover. The top is of solid gold beautifully inlaid with gold quartz in the finest mosaic work, hundreds of pieces being required for the construction of this exquisite cover.

The workmanship will bear the most exacting criticism, and the patient skill of the lapidist and the genius of the designer are freely shown here. It is as beautiful as a fresco and more like a painting than the work of the harder tools in jewelry.

The most elegant part of the whole casket is the exquisite piece of workmanship on the inside of the cover—it being a pictorial and historical representation of a buffalo hunt on the plains. The engraving of the landscape is very fine, the shrubbery and trees being in bas-relief. In the foreground is the railway track with two buffaloes dashing across it to evade the hunters who are in close pursuit. All of this is in alto-relievo and with great expression. The figures are not only correctly proportioned but skillfully handled, and the whole representation is artistically wrought; while the foreground is in high relief the background is in low relief, which decreases gradually in the distant perspective. The key is also inlaid with quartz.

The whole, weighing nearly nineteen pounds of solid gold and gold quartz, is valued, with the other articles, at 150,000 francs.

The case to contain the same is made of the different species of wood grown on the Pacific Coast.

The above description was written by a Paris connoisseur, in Paris, the world's art center, and was not disputed. No higher compliment could be paid to the San Francisco artist artisans that did the work or the jeweler who designed it. The exhibit was one that attracted universal attention.

Quartz sands, which are abundant all over the world, and especially so in California, are used for many purposes, as in mortar and cement, for grinding and polishing, cutting marble, glass making, etc. For the latter purpose the sand must be clean and free from impurities, except for the most ordinary qualities of ware.

GLASS.

Glass is an artificial silicate of soda or potash, to which other substances are added, all of them mineral, to produce varieties of quality, color, or appearance. The following are the most important: lead, bismuth, zinc, iron, manganese, copper, uranium, gold, tin, antimony, chromium, alumina, silver, cobalt, borax, strontia, baryta, fluorspar, and cryolite. The foundation of glass is silica, generally supplied in the form of quartz sand, but sometimes quartz rocks, flint, etc., are pulverized for that purpose.

The invention of glass antedates the earliest history. The discovery was probably the result of accident. Pliny relates the following account of its supposed origin, although it was probably known in prehistoric times: "In Syria, there is a region known as Phœnice, adjoining to Judæa, and inclosing between the lower ridges of Mount Carmelus a marshy district, known by the name of Cendebia. In this district it is supposed rises the river Belus, which, after a course of five miles, empties itself into the sea near the Colony of Ptolemais. The tide of the river is sluggish and the water unwholesome to drink, but held sacred for the observance of certain religious ceremonials. Full of slimy deposits and very deep, it is only at the reflux of the tide that the river discloses its sands, which, agitated by the waves, separate themselves from their impurities, and so become cleansed. It is generally thought that it is the acridity of the sea water that has this purgative effect upon the sand, and that without this action no use could be made of it. The shore upon which this sand is gathered is not more than half a mile in extent, and yet, for many ages, this was the only spot that afforded the material for making glass.

The story is that a ship laden with niter (alkali) being moored upon this spot, the merchants while preparing their repast upon the seashore, finding no stones at hand for supporting their caldrons, employed for the purpose some lumps of niter, which they had taken from the vessel. Upon its being subjected to the action of the fire in combination with the sand of the seashore, they beheld transparent streams flowing forth of a liquid hitherto unknown. This, it is said, was the origin of glass. Seutonius quotes Pliny to the effect that "the art of making glass malleable was actually discovered under the reign of Tiberius, and that the shop and tools of the artist were destroyed lest by the establishment of this invention gold and silver should lose their value. Dion adds that the author of the discovery was put to death."

Glass was manufactured in great abundance in the ancient cities of Rome, Carthage, Babylon, Tyre and Sidon, Memphis, and Thebes. In more modern times the manufacture was transferred to Constantinople and Venice.

White sands have been found in California. The tailings of some of our quartz mills are nearly pure silica; if not wholly free from metallic impurities they could probably be rendered so by careful washing. The more common varieties of glass are already manufactured in California, which will doubtless increase until the home demand is supplied. It has been difficult to obtain sand on the Pacific Coast for the finer manufacture of glass—that is, fully up to the requirements of the glassmaker. This difficulty will probably disappear when more careful trials are made of the beautiful white sands of the State, without the prejudice that seems to warp the judgment of workmen accustomed to the use of material from a particular locality, and who are inclined to attribute any fault in the product to the new.

GLASS MAKING IN CALIFORNIA.

Owing to the extent to which the business of preserving fruits, meats, and vegetables, the bottling of wine and mineral waters, and the manufacture of chemicals and patent medicines, is being carried on in California, the demand for bottles, vials, and various other glass vessels of the coarser kinds, has reached considerable proportions. To meet these requirements, two glass factories were originally founded in San Francisco, one, the Pacific Works, in 1862, and the other, the San Francisco, four years later, the two having since been united in one establishment bearing their conjoint names. At these works, located on King Street, near Fourth, are made glass wares of the several kinds above mentioned, also lamp chimneys and globes, retorts for use in chemical laboratories and acid works, carboys, etc. This company intend to engage shortly in the manufacture of goblets, druggists' material, flint glass, and other articles of the finer kinds, to which end they have projected an enlargement of their works, and brought from the East a number of artisans skilled in this branch of the business. With this addition perfected, the present working force, amounting to 150 hands, will be increased about one half. The money paid out here, on account of wages, amounts annually to nearly $100,000, which sum will hereafter be swollen to $150,000, at least. This company procure most of their sand from Antwerp, Belgium. It is said that the sand obtained from Monterey County does well enough for making ordinary wares, but does not answer for the finer kinds. Their supply of soda ash comes from England; of lime, from Cave Valley in this State. This company being desirous of obtaining a first-class sand nearer home, prospectors should keep an outlook for deposits of this description.

A company, mostly residents of Oakland, has lately been formed for the purpose of starting a window glass factory in that city, this being a distinct branch of glass making. In connection with the above business, this company will manufacture glass tiles by a patent process of which they are the owners. The proposed works are to be located on a four-acre lot at the foot of Linden Street, which, having a water frontage, constitutes an eligible site for the purpose. As to the time when these Oakland parties expect to commence active operations, we are not advised.

Silicified wood is a variety of quartz. The woody fiber is gradually replaced by quartz, leaving the form of the wood intact, so much so that sections cut and placed under the microscope show the characteristic grain of the wood, by which the genera may often be determined, and sometimes the species. Beautiful specimens of silicified wood are found in the hydraulic gold mines of the State. The petrified forest, in Sonoma County, is remarkable for the number of trunks lying on the surface of the ground. The beach at Pescadero, San Mateo County, has a wide celebrity for the beautiful pebbles found there. These are nearly all quartz, agates, carnelians, jaspers, and chalcedony, of many beautiful varieties. On the shore, under a low bluff, nearly at the sea level, a stratified sandstone dips from 65 to 72 degrees from the horizontal to the southwest. The strike is N. W. to S. E., magnetic. Upon this, unconformably, lies a sedimentary formation, more recent, in horizontal strata, consisting of sand, water-worn bowlders, and pebbles. This formation constitutes the bluff, and the pebbles on the beach result from its disintegration. The upper sedimentary seems to be formed from disintegration of the lower, which extends inland to an unknown distance. In the lower formation the sandstones are of different degrees of fineness, from the finest silt to very coarse conglomerate; in the conglomerate may be seen small bowlders of chalcedony, jasper, agate, and porphyry, which are the same as those found on the beach; but the latter are concentrated by long continued action of the waves, which have washed away the sand, disintegrated the sandstone bowlders, and gathered the harder pebbles together on the beach. Some of the sandstones are cemented by oxide of iron, and all the loose sands are highly ferruginous. On the way from Pescadero to the beach the road is cut through a formation not stratified, but in which the bowlders are imbedded. This general formation seems to be the same as is observed in the oil regions of San Mateo, Santa Clara, and Los Angeles Counties.

Some of the deposits of diatomaceous earths in the State are nearly pure silica. A deposit of a similar nature, at Staples' Ranch, San Joaquin County, but in which no diatoms have been found, gave the following results, by analysis made in the London Hospital:

Silica	94.64
Water	3.33
Alumina	.40
Sulphate of lime	1.63
	100.00

Quartz is very abundant in the State. The following localities produce the mineral in specially interesting forms:

Quartz crystals, doubly terminated, are found in Beveridge District, Inyo County; Modoc mine, Inyo County; Morning Star mine, Alpine County. Coated with malachite, at Panamint, Inyo County. On silver ore, Bodie, Mono County; No. 3782, fine crystals, same locality; No. 5163 is a long triangular prism, the edges modified by narrow planes, from the Standard mine, Bodie, same county. No. 13 is a large cluster of fine crystals, from the Wyoming mine, Panamint, Inyo County. Mariposa mine, Mariposa County; near Hornitos, fine, Mariposa County. No. 1451, Calaveras County. Fine crystals, Granite Basin, Plumas County (Edman). Red Hill, Placer County (Blake). Grass Valley, Nevada County, gold mines; often supporting gold between the crystals (Blake). Rock crystal, near Placerville, El Dorado County. No. 3706, rose quartz, massive, very fine, Hope Valley, Alpine County. No. 3707, rose quartz, Yokhe Valley, Tulare County. No. 3708, rose quartz, Plumas County. No. 4143, smoky crystals, Beveridge District, Inyo County. Smoky quartz crystal, six inches in diameter, found near Placerville, El Dorado County (Blake). No. 2446, smoky quartz, North Fork of Feather River, Butte County. Smoky (cairngorm), Summerfield, Mosquito Cañon, near Placerville, El Dorado County. No. 138, hacked quartz, with gold, Shasta County. No. 471, hacked quartz, Pine Tree mine, Mariposa County. No. 49, drusy quartz, Alpine County. No. 1446, quartz breccia, Hirchman's hydraulic mine, Nevada County. Hornstone, Mono County. Quartzite, Malakoff mine, Nevada County.

Agate.—San Luis Obispo County (Trask); Long Valley, Plumas County; in great variety at Spanish Creek, same county (Edman); Pescadero beach, San Mateo County.

Aventurine.—I have in my private collection a beautiful specimen of this variety of quartz, with section for the microscope; from an unknown California locality.

Bloodstone.—No. 4802 was found in gravel, near Windsor, Sonoma County. It is said also to be found in Jess Valley, Modoc County.

Carnelian.—Found on the beach above Crescent City, Del Norte County; Pescadero, San Mateo County; and on the shores of Lake Tahoe.

Cat's-eye.—Represented by a single specimen in the State Museum, No. 2265, from Calaveras County.

Chalcedony.—Nos. 2164 and 3721 are from Volcano, Amador County, where it occurs in many varieties; No. 1528 is from Pescadero beach, San Mateo County; Eclipse mine, Inyo County; Sonora trail, Alpine County; No. 546, from Murphy's, Calaveras County; No. 574, near St. Helena, Napa County; No. 962, Big Tank, Colorado Desert, San Diego County; No. 1206 (chalcedonic quartz), Vallecito, Calaveras County; No. 1397, Soledad Cañon, S. P. R. R., San Bernardino County; No. 1427, Douglassville, Tuolumne County; No. 1547 (chalcedonic bowlders), Bodie, Mono County; No. 2395, Sonoma County; No. 4349, with stibnite and cinnabar, Manhattan quicksilver mine, Napa County; No. 4283, Los Angeles County; beach at Crescent City, Del Norte County; hills back of Berkeley, Alameda County; large masses of white chalcedony, delicately veined, and mammillary sheets, occur in Monterey County, near the Panoches; in pear shaped nodules in the eruptive rocks between Williamson's Pass and Johnson's River, Los Angeles County (Blake).

Jasper.—No. 94 is from the Potrero, San Francisco, and has been mentioned before; found also at Claremont Hill, Plumas County; near St. Helena, Napa County; Tuolumne County; Crescent City, Del Norte County; Sausalito, Marin County; Mumford's Hill, Plumas County; (red) gold mines, Calaveras County, in the "Iron Hat" or croppings; (brown) Murphy's, Calaveras County (this stone polishes beautifully, and might be used for jewelry and ornamental purposes); (red) Monitor, Alpine County.

Quartz Sand.—No. 444, beach at Monterey, used for glass making in San Francisco; No. 4804, thirty-two feet below the surface at Lincoln, Placer County, with lignite in beds two to four feet thick; very pure quartz.

Silicified Wood.—No. 150, Portersville, Tulare County; No. 304, Columbia, Tuolumne County; No. 486, Eclipse mine, seven miles west of Lower Lake, Lake County; No. 1171, near Angel's Camp, Calaveras County; No. 1193, Gold Run, Placer County; No. 1251, Calaveras County; No. 1772, Dutch Flat, Placer County; No. 1855, near Roseville, Placer County; No. 2167, near Volcano, Amador County; No. 2387, Burnell Valley, Sonoma County; No. 1856, near Calistoga, Napa County; No. 2433, with lignite, Mount Diablo coal mine, Contra Costa County; No. 3423, Omega, Nevada County; No. 3444, Chalk Bluffs, Nevada County, in great variety; No. 3781, Duryea hydraulic mine, Chili Gulch, Calaveras County; No. 4113, San Luis Obispo County, twenty feet below the surface; Hirchman's hydraulic mine, near Nevada City, Nevada County; Mono Lake, Mono County; Santa Rosa, Sonoma County (wood before being silicified had been pierced by worms); Downieville, Sierra County; near Forest Hill, Placer County.

QUARTZITE—see Quartz.

122. QUICKSILVER. Etym. "*Living Silver.*" Mercury.

Mercury is one of the most beautiful and useful of metals, and the only one known to science which is fluid at ordinary temperatures. It is so volatile that it begins to vaporize at low temperatures—even when exposed to the sun's rays in Summer.

The vapors of mercury are, when strongly heated, highly expansive, and when confined, explosive, like steam, as Geoffroy discovered to his astonishment, when, at the suggestion of an alchemist, he placed some mercury in an iron globe, which he then put in the fire (with what motive history does not state). The result was a grand explosion, and the dissipation of the metal in invisible fumes.

Mercury does not become oxidized even when shaken in contact with oxygen gas. It has a strong affinity for sulphur, with which it combines when rubbed with it in a mortar. It is separated from its natural compounds by distillation with lime, iron scraps, carbonate of soda, or other reagents.

The atomic weight of mercury is 100.04 by the old system, which is doubled in the new. The symbol is (Hg.) from the Latin Hydrargysum, literally "silver water."

It has a specific gravity at 40° *above* zero of 13.545, while at 40° *below* it is 15.612. Until the year 1759 it was not known that it could be brought to the solid state. This fact was discovered by accident in making experiments with freezing mixtures. In the Winter of 1799 a mass of solid malleable mercury, weighing fifty-six pounds, was obtained. At Hudson's Bay very interesting experiments were made with congealed mercury. A mass was frozen and hammered on an anvil, of the same temperature, to a sheet as thin as paper. A piece of the mercury-foil was thrown into a glass of warm water, which was instantly turned into ice, while the mercury as quickly returned to its fluid state. So intense and energetic was the change that the glass was broken into fragments.

Mercury was well known to the ancients, who, however, seem to have had strange ideas regarding it. They thought it was silver in some peculiar allotropic state. The name "*Argentum Vivum*," by which they knew it, lead to the modern name "Quicksilver."

Four centuries before Pliny's time this metal is mentioned by Aristotle and Theophrastes, under the name of "fluid silver." Vitruvius describes a method of fire gilding copper and silver by its aid, much as the same process is conducted at the present day.

The alchemists named this metal after the Greek mythological god Mercury, and represented it by the caduceus or winged rod of that deity intwined by two serpents, or a modification of that symbol. Corrosive sublimate was known to the Arabian chemists and calomel to the alchemists. Cinnabar has been used from time immemorial as a face paint by savages.

Pliny writes that the Greeks obtained vermilion from the Almaden mines in Spain 700 years before the birth of Christ. It was known as "Minium," a name now applied to oxide of lead. It was found as a scarlet sand in the beds of rivers. Ten thousand pounds were sent to Rome annually, under seal, where it was manufactured into vermilion.

The word vermilion is of quite recent origin, being taken from the French word "vermeil," from "vermiculum," a name applied in the Middle Ages to *Kermes*, which is the Arabic name for an insect from which a red dye was obtained. The literal translation of *Kermes* is "little worm," hence the name "vermiculum" and "vermilion."

Metacinnabarite, described elsewhere, is a new and rare mineral discovered in the Redington mine. It is the black sulphide of mercury, and bears the same relation to cinnabar that ethiops mineral does to vermilion.

Vermilion was extensively manufactured by the Dutch for many years, and their product was highly esteemed. The Chinese have long manufactured a fine article, which is well known, and is sent to this country in small paper parcels. It is now made extensively in

England and the Eastern States of excellent quality, and there is no reason why it might not be produced in California to a great profit, as may be said of all the salts and preparations of mercury.

In first working the vast sulphur bank near Clear Lake the greatest difficulty was the presence of mercury, which blackened the sulphur when attempts were made to refine it.

In some of the California quicksilver mines the heat is uncomfortably great, and the gases which are generated quite dangerous—so much so that powerful blowing machines are used to cause an artificial draft.

There can be no doubt that the agencies which have produced older deposits of mercury, are now in active operation here. At the Valley mine, in Pope Valley, a small stream passes very close to the old workings, and in the pools caused by slight impediments in the bed of the stream, the bubbling of the gases may be seen at any time. The locality has recently gained quite a celebrity as a mineral spring under the name Etna Springs.

MINERAL FORMS.

Most of the mercury of commerce is obtained from the sulphide (cinnabar). The other minerals containing it are only regarded as mineralogical curiosities. But as it may be interesting to know them, they are given below, with the percentage of mercury they contain:

Ammiolite (antimoniate of mercury), 19 to 24; Amalgam (silver 34.3), 65.2; Calomel (chloride of mercury), 84.9; Coccinite (iodine of mercury); Tiemanite or onofrite (selenide of mercury), 65 to 74.5

Mercury is found in California, native disseminated in serpentine rocks, and as *Cinnabar* (sulphide of mercury). This mineral is of a bright red color, the streak scarlet. H.=2. 2.5, sp. gr.=8.99; composition (Hg. S.).

Mercury	86.2
Sulphur	13.8
	100.0

When prepared artificially it is called *vermilion* (mentioned above), which is much used as a pigment. In a closed tube alone it gives a *black sublimate*; with carbonate of soda, *metallic globules;* when pure it wholly volatilizes. The same test is a proof of the purity of artificial vermilion, a test I am sorry to say it will seldom stand.

Mercury, when impure, is dull in luster. When shaken in a bottle a black powder separates; when retorted a residue remains behind. If a globule is allowed to run down a gentle incline, on white and dry writing paper, it leavs a *tail* behind it. To purify it, it must be *retorted.*

The method of separating gold from amalgam gathered in mining, is given under the head of gold. Mercury is purified in the same manner. A piece of clean writing paper is then folded like a filter, and fitted into a clean glass funnel. In the point of the filter a pinhole is made. The mercury will pass through the pin-hole in a thin stream, leaving any mechanical impurity on the filter. In some cases this operation may require to be repeated. If filtered into a perfectly clean bottle, the mercury will be pure.

Mercury has many uses in the arts. It has the property of combining with other metals forming *amalgams*. This property is taken advantage of in mining and metallurgy. The gold in California and elsewhere is chiefly collected by the agency of mercury. An amalgam of mercury and tin forms the backing of mirrors, and is really the reflecting surface. It is used also in the arts in gilding metals. It is used to fill thermometers and barometers, and for filling pendulums of large clocks. Mercury is used in pharmacy, as calomel, corrosive sublimate, mercurial ointment, etc.

Although mercury is so beautiful, and while in a metallic state so harmless, yet when oxidized and combined with other elements it is the most deadly of poisons. Although instances are on record of large quantities having been swallowed without great inconvenience, yet the action of its salts on the animal economy is something fearful to contemplate.

But in the hands of skillful physicians it is much used as a medicine, and in some cases is almost a necessity. It is a question who used it first in medicine, but it is generally admitted that it was either Rhazes, who died in 932, or Avicenna, who lived until the year 1037.

Corrosive Sublimate.—Bichloride of mercury has since the advent of the cholera in Europe been brought prominently before the world as a *germicide*. That is, a substance which has the property of destroying disease germs; in other words, a perfect disinfectant. It is considered by the best authorities the most powerful germicide known.

Mercury is used in the chemical laboratory and in many minor ways. Sodium amalgam is employed in certain metallurgical operations described in the second annual report. It is prepared as follows. It should be freshly made to be effective. If long kept it becomes oxidized and does not give satisfactory results, and the coal oil poured in the bottle by the manufacturing chemist is detrimental to the collection of the gold. For these reasons it is sometimes unjustly condemned. It should be prepared by the miner himself, in quantities to suit, and be immediately used. The preparation is simple and requires no skill. Metallic sodium may be kept in a convenient wide-mouth bottle, covered with naphtha or coal oil. It is best to keep it in large pieces, and to cut it into small cubes when required. All that will be required for a single clean-up can be made in a small frying pan. The details of the operation are as follows:

The pan must be perfectly clean and dry. A small quantity of mercury from a fresh flask, or at least not contaminated with mineral impurities, say five or six pounds, is poured into the pan, and dried, first with a sponge, and then by heating hotter than boiling water, but not so much so as to volatilize any of the mercury, which would be dangerous to the health of the operator. In the meantime, a piece of sodium is taken from the bottle and wiped with a perfectly dry rag. It is then cut into half-inch cubes. This is done with a common knife, the metal cutting like wax. The mercury is taken out into the open air. The operator places himself on the windward side of the pan, and lifting one of the small cubes of sodium with a long pair of cupel tongs, or pointed wire, places it in the center of the warm mercury. A flash will follow, and a small quantity of the mercury will be volatilized. Another cube is laid in the same place, and the same flash will follow, but it will be less intense. This is repeated three or four times, when the sodium will sink down quietly. At the proper moment it will be observed that there is a solid mass of amalgam in the center. It will then be perfectly safe to stir the contents of the pan, when a few more cubes added will change the whole to a mass of beautifully crystallized sodium amalgam, which may be put into closely stoppered glass bottles, in which it will keep for some time without coal oil or other protection, but when the bottle is opened the whole should be used, as it will soon, otherwise, decompose and spoil. The bottles in which it is kept should be selected to hold just what is required for use at one time.

It will be found every way advantageous to the miner to make his sodium amalgam according to these directions. The precautions to be observed are to avoid the fumes of mercury during the operation, and to be sure that everything used is perfectly dry.

ASSAY OF MERCURY.

The assay of mercury is simple when approximative results only are sought. It may be assumed, however, that these assays termed "approximative," in contradistinction to "accurate," are sufficiently correct for ordinary purposes.

The best practical test, especially for the prospector, is to use the horn spoon, and treat the pulverized rock as for gold. If the rock contains cinnabar an intensely red powder, fringing the residue, will be obtained for a "prospect." If in a metallic state, minute globules will be the result. After a few trials the prospector will feel the utmost confidence in his assays, and will decide at a glance whether his ore contains mercury, and approximately the quantity. The best vessel for this assay is the *batea*, described elsewhere. If there is a particle of cinnabar present, it will be found at the point of the prospect, clearly distinct from all other substances. The value of the *batea* to the prospector cannot be too highly estimated, and it should come into more general use.

The usual assay is based on the fact that all compounds of mercury are volatile, and may be sublimed by heat, and again condensed by cold, thus freeing them from non-volatile impurities. If the mercury is in the metallic state sublimation separates it all without addition. But when combined with other volatile substances, something must be added to retain the impurities and allow the mercury only to sublime.

In a great majority of cases the assayer will find his sample to contain mercury, if at all, in the form of the sulphide.

Either carbonate of soda or metallic iron will decompose cinnabar. If carbonate of soda is used, part of its oxygen combines with part of the sulphur, forming sulphurous acid, setting carbonic acid free while the balance of the sulphur combines with the sodium. The mercury thus set free sublimes over in a state of purity.

In the case where iron is used, the sulphur combines with the iron, setting the mercury free, as before.

In conducting this assay certain precautions should be carefully observed. If the ore is rich, from ten to twenty grams is sufficient for assay; if rather poor, from one to five pounds must be taken. If the ore shows slight indications only of mercury, a large quantity must be concentrated by washing, in the manner before described, and the concentrations only submitted to sublimation. To insure correct results and a perfect decomposition, the ore must be finely ground and intimately mixed with the reagent used.

The best apparatus in which to make this assay is the ordinary iron retort, with cover and screw clamp, in common use by miners, described under the head of retorting or purifying metallic mercury. A very convenient substitute may be improvised by cutting off a piece of common iron gas pipe, one inch inside diameter and about a foot long, fitting a cap to one end and a reducer to one fourth inch to the other. A bent one fourth inch pipe, of any convenient length, screws into the reducer. Any gasfitter will understand this description. To charge the apparatus it is only necessary to remove the cap and on replacing it see that the joint is tight. To insure this a little fire clay or wet wood ashes may be rubbed into the thread of the screw.

To charge the retort, the cover is removed, and the charge introduced; a little wood ashes, made into a stiff paste, is placed between the rim of the retort and the rabbet of the cover, which must then be tightly screwed down and the oozing lute rubbed off and the joint carefully examined before placing the retort in the fire.

The assay must be prepared as follows: Equal volumes of the ore and dry carbonate of soda are intimately mixed and placed in the retort; a layer of carbonate of soda is added and the whole settled down by tapping gently on the table; the assay should not more than two thirds fill the retort. After luting the cover as before described, it is ready for the fire, which may be made of charcoal or wood, or the retort may be placed in an assayer's furnace.

The open end of the bent tube must dip beneath the surface of water held in a convenient vessel, which may be of iron, porcelain, or even wood. If the pipe dips too deeply there is danger of explosion, should the water pass into the hot retort as it cools and thus forms a vacuum. When the operation is complete, and no more mercury comes over, the end of the tube may be raised from the water, and the apparatus allowed to cool. The bent tube should then be carefully unscrewed from the cover of the retort, and gently tapped to insure the removal of any globules of mercury which may have remained in it. If any are found they must be added to the collected mercury in the dish. Before the water is poured off, the surface must be carefully examined to see that no minute globules float upon it. These are sometimes so small that they can be seen only by a powerful magnifying glass. If the eye is placed nearly on a level with the surface, a metallic film will be seen if any of the metal floats, in which case it is only necessary to stir the water briskly, when the globules will sink and attach themselves to those beneath.

The water may then be carefully poured off, and the mercury, which is rarely found in a single globule, be washed into a small clean evaporating dish. The surplus water is then removed by means of pieces of blotting paper, or what is better, filtering paper. The dish must be again half filled with water and its contents boiled. After which the mercury must be again dried with blotting paper and placed in a watch-glass or porcelain cup and weighed.

Mercury is always calculated in percentage. Thus, if the ore weighed one hundred grams and the mercury one, then the ore contained one per cent of mercury.

A very ingenious method of assay of mercury has been contrived, which, however, has some disadvantages.

The weighed and pulverized ore is placed in a porcelain crucible, the edges of which are ground evenly. Half its weight of pure iron filings are mixed with it and covered with a thin layer of the same. A concave cover of pure gold is then placed over the crucible and the concavity filled with water. The crucible is then placed over a Bunsen gas burner, or alcohol lamp, and heated for ten minutes. The mercury sublimes and attaches itself to the gold. When the operation is complete, the cover is removed, washed carefully with alcohol, dried in a water bath, and weighed. It is then heated red hot, to dispel the mercury, and again weighed. The loss in weight indicates the mercury in the ore. No other metal than gold would give correct results, as that metal does not oxidize or lose weight when strongly heated.

A modification of this assay, which, in the hands of a skillful manipulator, gives very accurate results, may be made in a glass tube. The tube for this purpose should be of hard German glass, of about half an inch internal diameter, five or six inches long and closed at one end. The amount weighed out of the ore should vary from half a gram to one gram, according to the richness of the ore. The assay must be mixed on a clean piece of writing paper with carbonate of soda, which has recently been heated to redness to expel water. The soda should equal the assay in volume. To introduce it into the tube, a very narrow strip of writing paper should be prepared, which, between the thumb and finger, is easily formed into a trough. The mixture is placed in this trough, which is gently pushed down to the bottom of the tube while in a horizontal position. When the tube is again held vertically, the mixture will fall to the bottom of the tube, leaving the other portions clean. This precaution is necessary, as any particles adhering to the inside of the tube interfere with the assay. On removing the paper slip and finding the glass above the assay perfectly clean, the tube may again be placed horizontally and shaken down a little, so as to leave a space over the mixture to allow the gases and mercurial fumes to pass to the cooler portions of the tube when heated, without the violent bubbling which would otherwise occur. The end of the tube in which the assay has been placed is then gently heated over a smokeless flame, which may be that of an alcohol lamp or a Bunsen burner. Very soon moisture will be given off, even although the soda may have been dried as directed. This comes from the ore, which cannot be dried safely before mixing. This moisture must be slowly driven—by gradually heating the tube—to a position beyond that of its first condensation, and removed before the mercury begins to sublime, by introducing a slip of dry filtering paper made into a roll. As the heat is increased, fumes of mercury are seen to arise and form a cloud in the tube. These soon condense, and form globules inside of the position first occupied by the moisture. When this is seen to occur, the heat may be increased by urging the flame with a mouth blowpipe, until the closed end of the tube is more than red hot, and the soda is in a state of fusion, when the tube may be set aside and allowed to cool. It will be found by examining the sublimate of mercury that there is a clean portion of the tube between it and the fused assay. If a deep scratch with a triangular file be now made at this part of the tube, the end containing the assay may be broken off, leaving the mercury undisturbed in the other portion. Now, if the tube be placed vertically, one end resting in a clean watch-glass, the mercury may be washed down perfectly by the aid of a small washing bottle. It is then an easy matter to dry the globule so obtained with blotting paper, and to weigh it.

It is more accurate to introduce a piece of pure gold foil, the weight of which is known, and with a small clean piece of wood to push it about in the tube until it attracts every particle of mercury. The gold is then removed, washed in distilled water, in a clean capsule, dried by being laid on filtering paper, and lastly in the air. The assay is then weighed on a very delicate balance, and the weight of the gold deducted.

This method, if carefully conducted, is very delicate, and may be relied on. It will give results in ore which will yield no mercury in a retort, or rather which cannot be collected from a retort assay, and the whole operation is under the eye, as the most minute trace of sublimate can be seen through the tube. It will be necessary in some cases, when the ore is rich, to increase the quantity of carbonate of soda, or decrease the ore, should a red or black sublimate be obtained, instead of a metallic one.

The assayer may under certain circumstances desire to practice the wet assay. To do this, all the appliances of an analytical laboratory, and considerable skill in manipulating, are requisite.

The usual reduction agent is proto-chloride of tin. The mercury compound, if solid, must be digested with strong hydrochloric acid and carefully decanted. This process must be repeated until all the mercury is in solution. If the solution of proto-chloride of tin is not clear, it must be made so by adding a drop or two of hydrochloric acid. The clear solution must then be added to the mercury solution in slight excess; the whole boiled, but only for a moment, to prevent loss by volatilization. On cooling, the mercury is found in the form of a black precipitate. The supernatant liquid must then be removed with a syphon and the precipitate boiled with dilute hydrochloric acid, which causes the mercury to form globules. It is then well washed, first with very dilute hydrochloric acid and finally with distilled water and dried, first with bibulous paper and then under a bell glass, over sulphuric acid. After which it is weighed.

When it is necessary to estimate mercury in a solution containing nitric acid, this acid must be removed, which may be done by evaporation with hydrochloric acid. The addition of hydrochloric acid and evaporation must be continued until no more smell of chlorine can be detected. It is very difficult to obtain correct results in the presence of much nitric acid. It is best, in such a case, to verify the results by some other method.

METALLURGY.

The metallurgy of mercury is more simple than that of any other metal. What has been said of the assay by sublimation, applies also to the recovery of mercury from its ores in a large way, except that generally no reagent is added to decompose the sulphide of mercury.

In the great furnaces employed, the sulphur burns away. To explain the process more fully, it may be said that the sulphur, which is combined with the metal, oxidizes when subjected to great heat, and the sulphurous acid so formed passes off, leaving the mercurial vapor to condense in the capacious chambers.

THE IDRIA MINE, AUSTRIA.

The furnaces formerly in use here were of simple construction, but of great size. In a central chamber, the ore in large lumps was placed over a fireplace of such construction that an intense heat could be produced; the ore being piled loosely in large lumps to admit of the passage of air. The pulverent ore, of which there is always some produced at the mines, was placed in earthern vessels, open at the top. The fire was gradually increased like that of a brick-kiln, until everything volatile was driven off. The mercurial fumes, mixed with those of sulphur, and some steam, passed through a succession of high chambers, entering each at the top, and passing to the next through an opening at the bottom. Most of the mercury condensed in the first chamber, but in the other chambers some metal was found mixed with soot. The furnace was allowed to cool between the working of each charge, which occasioned loss of time. In some of the improved furnaces in use on this coast, the charging and discharging is continuous, which is regarded as a great improvement. The furnaces now used at Idria are the most improved modern structures, fully up to those of California.

AT ALMADEN, SPAIN,

The treatment is somewhat different. The fireplace and receiving chamber for the ore are at the end of the furnace. The partly condensed vapors pass through a multitude of jointed earthenware receivers called "aludels," which are exposed to the air. At a depression in the center of the furnace, the aludels are loosely put together, to allow of the escape of condensed mercury, which is conveyed by channels to a central receiver, while the fumes pass on to a large chamber, in which final condensation takes place. This description can scarcely be understood without a drawing.

At the New Almaden, in California, the first furnaces were constructed on the same general principle of those at Idria. It is stated in a history of that mine that a "new process of smelting the ore was discovered by a blacksmith named Baker, which succeeded after $387,800 had been expended in experiments."

WASTE OF MERCURY.

A moment's thought will convince the intelligent reader that if there was no mechanical loss, the same mercury could be used over and over again, until the end of time, but it is well known that this loss is enormous. In all the cañons leading down from the Comstock mines, the ground is permeated with quicksilver, which has been lost, not to say thrown away, in working the ores.

If a specimen of the ordinary milling ore from the Comstock mine be examined microscopically, it will be found to consist of certain silver minerals dispersed through a large quantity of quartz. The proportion of quartz, or silica, in two samples analyzed by Mr. Arnold Hague, was respectively 84 and 91 per cent. By the present process, this large proportion of worthless matter must be saturated—so to speak—with mercury, to extract the silver from the small silver-bearing portion. Experiments have fully shown that owing to the greater specific gravity of the sulphurets, they may cheaply be separated from the quartz. Would metallurgists substitute a proper treatment, based on this general idea, and amalgamate the concentrations only, the saving in mercury would be very great.

PRODUCTION OF MINES IN CALIFORNIA—BY FLASKS.

Years.	New Almaden	New Idria	Redington	Sulphur Bank	Guadalupe	Great Western	Napa Con.	Pope Valley
1850	7.723	Production from 1858 to 1866—17,455 flasks; no yearly details obtainable—included in production of Various Mines.	------	*	* Yearly production previous to 1875 not obtainable; estimated at 20,000 flasks: included in production of Various Mines.	------	------	*
1851	27.779		------	------		------	------	------
1852	15,901		------	------		------	------	------
1853	22.284		------	------		------	------	------
1854	30,004		------	------		------	------	------
1855	29,142		------	------		------	------	------
1856	27,138		------	------		------	------	------
1857	28,204		------	------		------	------	------
1858	25.761		------	------		------	------	------
1859	1.294		------	------		------	------	------
1860	7,061		------	------		------	------	------
1861	34,429		------	------		------	------	------
1862	39,671		444	------		------	------	------
1863	32,803		852	------		------	------	------
1864	42,489		1,914	------		------	------	800
1865	47,194		3,545	------		------	------	------
1866	35,150	6,525	2,254	------		------	------	------
1867	24,461	11,493	7,862	------		------	------	------
1868	25,628	12,180	8,686	------		------	------	1,122
1869	16,898	10,315	5,018	------		------	------	1,580
1870	14.423	9.888	4,546	------		------	------	1,220
1871	18,568	8,180	2,128	------		------	------	1,970
1872	18,574	8,171	3,046	------		------	------	1,830
1873	11,042	7.735	3,294	------		340	------	1,955
1874	9,084	6,911	6,678	573		1,122	------	1,645
1875	13,648	8,432	7,513	5,372	3,342	3,384	------	1,940
1876	20,549	7,272	9.183	8,367	7,381	4,322	573	300
1877	23,996	6,316	9,399	10,993	6,241	5,856	2,229	1,060
1878	15,852	5,138	6,686	9,465	9,072	4,963	3,049	1,075
1879	20,514	4,425	4,516	9,249	15,540	6,333	3,605	1,325
1880	23,465	3,209	2,139	10,706	6,670	6,442	4,416	275
1881	26,060	2,775	2,194	11,152	5,228	6,241	5,552	------
1882	28,070	1,953	2,171	5,014	1,138	5,179	6,842	------
1883	29,000	1,606	1,894	2,612	84	3,869	5,890	------
Totals	793,859	122,524	95,962	73,503	54,696	48,051	32,156	18,097

Years.	Great Eastern	St. John	Altoona	Oceanic	Oakland	California	Sunderland	Cloverdale	Abbott	Manhattan
1850	*	*	* Some was produced prior to 1875, but no record kept; estimated production previous to 1875 1,000 flasks, included in production of Various Mines.	*	*	*	*	*	*	* Yearly production previous to 1876 not obtainable; estimated at 3,594 flasks; included in production of Various Mines.
1851	------	------		------	------	------	------	------	------	
1852	------	------		------	------	------	------	------	------	
1853	------	------		------	------	------	------	------	------	
1854	------	------		------	------	------	------	------	------	
1855	------	------		------	------	------	------	------	------	
1856	------	------		------	------	------	------	------	------	
1857	------	------		------	------	------	------	------	------	
1858	------	------		------	------	------	------	------	------	
1859	------	------		------	------	------	------	------	------	
1860	------	------		------	------	------	------	------	------	
1861	------	------		------	------	------	------	------	------	
1862	------	------		------	------	------	------	------	------	
1863	------	------		------	------	------	------	------	------	
1864	------	------		------	------	------	------	------	------	
1865	------	------		------	------	------	------	------	------	
1866	------	------		------	------	------	------	------	------	
1867	------	------		------	------	------	------	------	------	
1868	------	------		------	------	------	------	------	------	
1869	------	------		------	------	------	------	------	------	
1870	------	------		------	------	------	------	------	------	
1871	------	------		------	------	------	------	------	------	
1872	------	------		------	------	------	------	------	------	
1873	------	------		------	------	------	------	------	------	
1874	------	1,743		------	------	------	------	------	------	
1875	412	1,927	533	------	------	------	------	------	------	
1876	387	1,683	1,979	2,358	2,150	965	1,570	1,028	1,436	976
1877	505	1,463	1,317	2,575	1,395	1,516	735	1,291	836	439
1878	1,366	------	1,534	1,679	1,615	1,640	472	116	------	------
1879	1,455	1,290	1,919	779	1,505	1,110	------	18	------	------
1880	1,279	------	245	------	166	422	------	------	------	------
1881	1,065	------	------	------	------	------	------	208	------	------
1882	2,124	------	------	------	------	------	------	------	------	------
1883	1,669	------	------	------	------	------	------	------	------	------
Totals	10,262	8,598	7,527	7.391	6,831	5,653	2,777	2,661	2,272	1,415

* Not in operation in March, 1884. † Yearly.

Production in California for thirty-four years------

Production in Austria for thirty-four years------ 275,9

Production in Spain for thirty-four years------ 1,045,4

Italy and other countries, present yearly production estimated------

San Francisco, California, March, 1884.

RS—COMPILED BY J. B. RANDOL, NEW ALMADEN, CALIFORNIA.

	Mt. Jackson	Bacon	Bella Union	American	Porter	Wall Street	Rattlesnake	Kentuck	Various Mines	Total Yearly Production of California Mines	Exports from San Francisco by Sea and Rail—By Flasks	Price in San Francisco per Flask. Highest.	Price in San Francisco per Flask. Lowest.	Production of the Idria Mine, Austria—By Flasks	Production of the Almaden Mine, Spain, in periods of five years—By Flasks	Price in London per Flask. Highest.	Price in London per Flask. Lowest.	Year.
	*	*	*	*	*	*	*	*		7,723	6,467	$114 75	$84 15	4,100		£15	£13 2s. 6d.	1850
										27,779	10,791	76 50	57 35	4,092		13 15s.	12 5	1851
									4,099	20,000	21,458	61 20	55 45	4,085	101,517	11 10	9 7 6	1852
										22,284	18,800	55 45	55 45	4,409		8 15	8 2 6	1853
										30,004	20,963	55 45	55 45	4,060		7 15	7 5	1854
									3,858	33,000	27,165	55 45	51 65	4,446		6 17 6d.	6 10	1855
									2,862	30,000	23,740	51 65	51 65	5,935		6 10	6 10	1856
										28,204	27,262	53 55	45 90	9,189	110,058	6 10	6 10	1857
									5,239	31,000	24,412	49 75	45 90	4,977		7 10	7 5	1858
									11,706	13,000	3,399	76 50	49 75	8,239		7 5	7	1859
									2,939	10,000	9,488	57 35	49 75	4,821		7	7	1860
									571	35,000	35,995	49 75	34 45	6,493		7	7	1861
									1,885	42,000	33,747	38 25	34 45	4,712	122,117	7	7	1862
									6,876	40,531	26,014	45 90	38 25	5,878		7	7	1863
									2,286	47,489	36,927	45 90	45 90	7,263		9	7 10	1864
									2,261	53,000	42,469	45 90	45 90	4,908		8	7 17 6	1865
									2,621	46,550	30,287	57 35	45 90	5,327		8	6 17 6	1866
									3,184	47,000	28,853	45 90	45 90	7,532	153,224	7	6 16	1867
									112	47,728	44,506	45 90	45 90	8,253		6 17	6 16	1868
										33,811	24,415	45 90	45 90	9,179		6 17	6 16	1869
										30,077	14,240	68 85	45 90	10,745		10	6 16	1870
									840	31,686	16,339	68 85	57 35	10,904		12	9	1871
										31,621	16,780	66 95	65 00	11,116	165,608	13	10	1872
									3,276	27,642	11,164	91 80	68 85	10,939		20	12 10	1873
										27,756	11,750	118 55	91 80	10,789		26	19	1874
	26					65	65		3,591	50,250	37,829	118 55	49 75	10,717		24	9 17 6	1875
7	128	150	271	250	100	74		54	1,161	75,074	49,046	53 55	34 45	10,794		12	7 17 6	1876
6	268	150			100				250	79,396	52,695	44 00	30 60	11,020	208,200	9 10	7 2 6	1877
	158									63,880	41,877	35 95	29 85	10,403		7 5	6 7 6	1878
	17								84	73,684	62,845	34 45	25 25	11,153		8 15	5 17 6	1879
										59,926	46,294	34 45	27 55	12,356	41,640†	7 15	6 7 6	1880
									376	60,851	45,799	31 75	27 90	11,333	50,353	7	6 2 6	1881
									241	52,732	40,417	29 10	27 35	11,663	46,143	6 5	5 15	1882
									101	46,725	37,867	28 50	26 00	13,152	46,591	5 17 6	5 5	1883
3	597	300	271	250	200	139	65	54	60,419	1,357,403	982,100	$118 55	$25 25	275,982	1,045,451	£26	£5 5s.	

,357,403 flasks, each of 76.50 pounds avoirdupois.

,321,433 } flasks, each of 75 pounds Spanish=34,507 kilograms=76.07 pounds avoirdupois.

2,000 flasks.

LOCALITIES.

Mercury is found in but few localities in the world. The mines of Almaden in Spain, and the Idria in Austria, supply nearly all the mercury in the eastern hemisphere. The former are the most extensive and important in the world. The average richness of all the ore extracted is fully ten per cent. Immense beds or deposits of cinnabar are found at times from forty to fifty feet in thickness. The yield of 1850 was 2,500,000 pounds of metal.

The Idria mines, like the Almaden, have been worked for hundreds of years, and still produce large quantities of mercury. From 1843 to 1847, the average annual yield was 358,281 pounds. The yield of both the Idria and Almaden mines from 1850 to date are given in the table of Mr. J. B. Randol attached to this report.

The quicksilver mines of Peru were in former years of great importance. They were known to the inhabitants long before the invasion of the Europeans, although historians state that they used the red pulverulent cinnabar as a paint, but did not know the method of extracting the metal from it. Although as in California, traces of mercury are found widespread in Peru, the only mines of great importance are found in the Province of Huancavelica, the mine of Santa Barbara, known as the "Great Mine," being the most extensive and prolific. It has been worked since the year 1566. About the year 1576 the method of extracting silver and gold by amalgamation was discovered, which increased the demand for mercury and enhanced its price. To supply this demand, the Santa Barbara mine was worked to its utmost extent, much as the mines of mercury are at the present day, and for exactly the same reason. Between the years 1598 and 1684, the production reached its extreme, after which it gradually declined. The mines were controlled by the Spanish Government, which, knowing that silver could not be produced without its use, sold it to the miners in such quantities as it chose, and claimed a tax on silver in proportion, holding it as a check on the amount of silver which ought to be produced. About the year 1790, the Santa Barbara mine was ruined by the Superintendent, in his eagerness to produce the greatest possible amount of mercury, taking out the supporting pillars, which caused the roof to fall in and choke the mine. This accident proved to be a great calamity, and for some time materially checked the production of the precious metals. For many years these mines have remained unworked.

DEPOSITS IN CALIFORNIA.

Mercury was known to exist in California long before gold was discovered. As long ago as 1845 a company was formed to work the New Almaden mine.

There are some peculiarities about the quicksilver mines of California that are worthy of attention. It is generally admitted, as stated before, that the agencies are now at work in these mines by which other fissures have in ages past been filled with the various metals.

The daily and yearly production of cinnabar, sulphur, metallic mercury, and even gold and silver, may be studied as the labor of a colony of bees can be watched in a hive. Mr. Attwood, of this city, who has given the subject much thought and study, says: "Cinnabar deposits are plutonic and occur in volcanic fissures filled by the condensation of metallic vapors which find their way from below, and condense on the sides of such fissures; also, in the looser portions of the adjacent rocks which have been softened and rendered porous by the heated vapors."

Dr. Oxland, formerly manager of the Borax Lake Company's works, has published some very interesting notes on the same subject. The sulphur bank, since proved to be a valuable quicksilver deposit, was carefully studied by him. He found this deposit to be constantly forming with evolution of carbonic acid, aqueous vapors, and boracic acid. The temperature of the vapors was 95° F., and he found them to be the agencies which brought gold, silver, iron, and mercury to the surface and deposited them on the sides of the fissures and seams in which gelatinous silica also forms, becoming indurated in time to opal. There is also a tarry hydrocarbon found pervading the silica, in which case metallic mercury was shown to replace the cinnabar. There is a striking similarity between some of these veins and the Mexican mine at Virginia City; so much so as to lead to the assumption that the Comstock ledge is the result of similar action.

It is unfortunate for the army of quicksilver prospectors, that *indications* of cinnabar are encountered in almost every part of the Coast Range. If to find cinnabar was in every case to discover a quicksilver mine, that metal would soon be a drug in the market. Prospectors are, therefore, cautioned not to let their hopes eclipse their discretion. The mines which have produced quicksilver in California and the quantity from each, are shown by the tables of Mr. Randol.

HISTORY AND CONDITION OF THE INDUSTRY IN CALIFORNIA.

Cinnabar Deposits.—There are in this State many deposits of cinnabar that, with the price of quicksilver doubled, could be worked with profit; the counties most distinguished for their wealth of cinnabar being Santa Clara, Fresno, San Luis Obispo, Trinity, Napa, Sonoma, and Lake, all containing mines that have heretofore been more or less worked, and in some of which mines are still being actively operated. Many of the deposits in these counties are characterized by certain peculiar features; thus, the New Almaden, the principal mine in Santa Clara County, is remarkable for its ore-producing capacity and the large production it has made; this being not only the first mine opened up, but also by far the most prolific in the State. The Altoona, the only mine in Trinity County, is noted for yielding an exceptionally high grade ore, while Napa, Sonoma, and Lake Counties, are conspicuous for extent of mineral territory and the great number of ore-bearing deposits, large and small, found within their limits.

Present Status of the Business.—This branch of mining in California is, and for the past seven or eight years has been languishing under low prices and diminished consumption, and this, notwithstanding the output of these mines has meantime been largely reduced. Some eight or nine years ago, when this metal was selling at from $1 40 to $1 50 per pound, these high prices led to such an over production as caused them to speedily decline, the wholesale price for the last eight years having averaged hardly more than forty-seven cents per pound. During this period of high prices a great many new mines were opened, and some of them equipped with reduction works, the most of these being located in Napa, Sonoma, Lake, and San Luis Obispo Counties. The drop in prices has led to a suspension of work on nearly all of these properties; the only quicksilver mines in the State that are now making any considerable production being the New Almaden, New Idria, Napa Con., Great Western, and the Redington, and these are all being run on a very small profit margin, so small that some companies are considering the policy of curtailing operations or suspending them altogether, being averse to wearing out their plant and to the further exhaustion of their ore stocks without any adequate return. The Sulphur Bank mine, formerly an active producer, was, for the reasons above mentioned, closed in 1883, and has since remained idle. How great the falling off in the product of the State has been during the past few years is shown by Mr. Randol's table.

The impetus so given to quicksilver mining in California, beginning in 1873, culminated three years latter, at which time more than thirty mines were making a greater or less production in different parts of the State, besides a great many locations that were being prospected, mostly in a small way. All of these producing mines were equipped with some sort of reduction works, and generally also with hoisting gear, the former consisting in some cases of mere retorts, or small furnaces, though a much greater number were outfitted with several furnaces of the best models and of large capacity. Operations have not only been suspended on nearly all of these mines, but, with the present outlook of the quicksilver market, they may be considered practically abandoned. The losses incurred by reason of these hasty and otherwise ill-advised movements were very heavy, having amounted, labor and money included, to millions of dollars. Scarcely ever in the history of this industry has the price of quicksilver been so low as it is now, nor have extreme low rates ever before held for so long a time as during the present era of depression. The lessened consumption of quicksilver, above alluded to, has grown out of diminished requirements for the mines on this coast, more especially those on the Comstock Lode. With a view to improving prices efforts were, from time to time, made to induce mine owners to take some concerted action looking to a restricted production, but as yet without avail, parties concerned being unable to agree upon a plan of procedure satisfactory to all.

Although the business of quicksilver mining was commenced in this State by the New Almaden company as early as 1846, not until 1850 was much metal turned out. Since that time the business has gone on with scarcely any interruption, the large quantity of 1,432,787 flasks, each containing 76.5 pounds avoirdupois, having been produced to date.

Mr. Randol's table shows the annual and total amount of quicksilver made in this State for the past thirty-five years, and of the first four months of the present year. It also gives the production of the Idria mine in Austria, and the Almaden in Spain, with prices in London highest and lowest for each year. It has been carefully corrected by Mr. Randol for this report, and is probably the most complete and reliable table ever published.

Exports.—Of the quicksilver produced in California, about twenty-five per cent is consumed on this coast, the balance being exported to the Eastern States and foreign countries. Of last year's production, 38,165 flasks, valued at $1,037,989, were so disposed of, 16,330 flasks having been shipped to China, 10,584 to Mexico, and 8,018 to

New York, with a little also to South and to Central America, Australia, Japan, British Columbia, etc. Formerly Great Britain took a good deal of our quicksilver, but since 1868 we have sent hardly any to that country, which of late years has obtained its supply chiefly from the Almaden mine, controlled by the Spanish Government. The largest exportations in any one year amounted to 62,845 flasks, made in 1879. The low duty on quicksilver—only ten per cent *ad valorem*—admits of the foreign article being largely imported into this country, the receipts from London having amounted in 1882 to 13,116 flasks, which quantity was considerably increased the following year.

Capital Invested, Labor Employed, Wages Paid, etc. — The capital invested in the live mines of California amounts at the lowest calculation to $3,000,000, this being aside from the large sums lost through unfortunate ventures and depreciation in the value of this species of property. The number of men employed in and about the quicksilver mines and furnaces in this State is, at the present time, something over one thousand, besides half as many more wood choppers, teamsters, timber cutters, etc., working on wages or contract, nearly one half of the entire number being in the service of the New Almaden Company. In the matter of nationality, these employés rank as follows: Mexicans, Chilenos, Cornishmen, Swedes, Americans, the latter being mostly engaged in teaming, wood chopping, etc. The day's work here is generally limited to ten hours, furnacemen working twelve-hour shifts. Miners usually receive $2 50 to $3 and surfacemen $2 per day, all boarding themselves where these rates are paid. Furnacemen are paid $2 50 per day, mechanics and foremen, $3 to $4. Where the men are boarded, a reasonable deduction is made from these prices, single men paying seventy-five cents per day for board, and about $5 per month for lodging. Men with families are furnished by the company with dwellings, for which they are charged a moderate rent, about $4 monthly.

NOT A PROFITABLE BUSINESS—NEED OF FURTHER PROTECTION.

As the value of the quicksilver produced in California approximates closely $50,000,000, this business has, of course, been of great public benefit, by reason of the large amount of labor it has employed and the subsistence it has afforded other industries. But, at the same time, this business has not, as a whole, proved very profitable to those engaged in it. So far as known the only quicksilver mines in the State that have ever paid much more than expenses are the New Almaden, New Idria, Redington, Napa Consolidated, and Great Western. All of these mines have one time or another paid dividends, and some of them in large amounts, the Redington a total of more than a million dollars, but only two or three of them have been making any net earnings of late, nor are they likely to make any hereafter unless a heavier duty shall be placed on the imported article. In the absence of such relief it may even happen that nearly all of the now producing mines in this State will, before long, be forced to close down.

PRODUCTION OF QUICKSILVER IN CALIFORNIA FOR THE YEARS 1883 AND FIRST FOUR MONTHS OF 1884.

Furnished by J. B. Randol.

	Ætna.	Napa.	Great Western.	Sulphur Bank.	Redington.	Great Eastern.	New Idria.	Guadalupe.	Various.	Total (flasks).	New Almaden.	Grand Total (flasks).	Price in San Francisco (per flask). Highest.	Price in San Francisco (per flask). Lowest.
January	----	590	390	280	367	262	112	77	7	2,085	2,497	4,582	$26 75	$26 00
	329	135	373	263	127	28	103	----	7	1,365	1,440	2,805	26 25	26 00
February	----	295	364	310	181	156	133	7	4	1,450	2,150	3,600	27 25	26 00
	276	174	241	----	104	9	59	----	----	863	1,458	2,321	29 00	26 00
March	----	485	305	335	202	162	142	----	14	1,645	2,230	3,875	28 00	26 75
	249	152	223	68	123	2	36	----	----	853	1,606	2,459	29 00	28 00
April	----	530	294	310	243	142	76	----	3	1,598	1,756	3,354	27 00	26 75
	422	69	232	76	50	----	75	----	----	924	1,785	2,709	29 00	28 00
May	----	325	293	350	135	164	144	----	13	1,424	2,344	3,768	27 00	26 75
June	----	360	400	91	165	184	137	----	10	1,347	2,214	3,561	28 50	26 75
July	----	452	446	130	141	150	85	----	2	1,406	2,618	4,024	28 50	27 50
August	----	695	315	112	94	76	139	----	----	1,431	3,000	4,431	27 50	26 25
September	----	750	297	265	45	81	164	----	30	1,632	3,010	4,642	26 75	26 25
October	----	521	215	206	109	134	272	----	----	1,457	2,672	4,129	26 50	26 50
November	----	613	208	160	78	102	115	----	----	1,276	2,212	3,488	26 50	26 00
December	----	274	342	63	134	56	87	----	18	974	2,297	3,271	26 25	26 00

NOTE.—The upper figures are for the year 1883, the lower for 1884, to May 1.

TABLE FOR CHANGING THE PRICE OF QUICKSILVER IN FLASKS TO AVOIRDUPOIS POUNDS—J. B. RANDOL.

New Almaden quicksilver, "A" brand, in flasks containing 76½ pounds avoirdupois.*

Per Flask.	Equivalent in Cents Per Pound.	Per Flask.	Equivalent in Cents Per Pound.	Per Flask.	Equivalent in Cents Per Pound.	Per Flask.	Equivalent in Cents Per Pound.
$26 00	33.98^{7}	$29 00	37.91^{1}	$32 00	41.83^{5}	$35 00	45.75^{9}
26 25	34.31^{4}	29 25	38.23^{8}	32 25	42.16^{2}	35 25	46.07^{8}
26 50	34.64^{1}	29 50	38.56^{5}	32 50	42.48^{9}	35 50	46.40^{5}
26 75	34.96^{8}	29 75	38.89^{2}	32 75	42.81^{6}	35 75	46.73^{2}
27 00	35.29^{5}	30 00	39.21^{9}	33 00	43.14^{3}	36 00	47.05^{9}
27 25	35.62^{2}	30 25	39.54^{6}	33 25	43.47^{0}	36 25	47.38^{6}
27 50	35.95^{0}	30 50	39.87^{3}	33 50	43.79^{7}	36 50	47.71^{3}
27 75	36.27^{6}	30 75	40.20^{0}	33 75	44.12^{4}	36 75	48.04^{0}
28 00	36.60^{3}	31 00	40.52^{7}	34 00	44.45^{1}	37 00	48.36^{6}
28 25	36.93^{0}	31 25	40.85^{4}	34 25	44.77^{8}	37 25	48.69^{3}
28 50	37.25^{7}	31 50	41.18^{1}	34 50	45.10^{5}	37 50	49.02^{0}
28 75	37.58^{4}	31 75	41.50^{8}	34 75	45.43^{2}	37 75	49.34^{7}

* Spanish and Austrian quicksilver flasks contain 75 pounds Spanish, equal to only 76.03 pounds avoirdupois.

ANNUAL EXPORTS OF QUICKSILVER FROM SAN FRANCISCO BY SEA FOR TWENTY-FOUR YEARS.

Years.	New York.	Great Britain.	China and Hongkong.	Japan.	Mexico.	Chili.	Peru.	Central America.	Australia, etc.	Panama.	British Columbia.	Miscellaneous.	Total Flasks.
1860	400	—	2,715	—	3,886	1,040	750	—	100	130	326	—	9,347
1861	600	2,500	13,788	50	12,061	2,058	2,804	110	1,850	57	116	—	35,994
1862	2,265	1,500	8,725	25	14,778	1,746	3,439	40	800	424	5	—	33,747
1863	95	1,063	8,889	—	11,590	500	3,376	40	300	120	42	—	26,015
1864	1,495	1,609	18,908	262	7,483	2,674	4,300	30	100	45	21	—	36,927
1865	6,800	10,400	14,248	500	2,789	2,000	5,500	8	200	—	24	—	42,469
1866	3,800	4,000	10,252	—	9,561	500	2,500	81	575	10	6	2	31,287
1867	2,900	1,500	9,811	200	10,043	800	3,000	30	550	—	20	—	28,854
1868	4,500	4,000	16,785	—	14,121	—	2,500	1	1,580	—	20	—	43,507
1869	1,500	—	11,600	30	8,010	1,400	1,500	20	300	1	4	—	24,365
1870	1,000	—	4,050	40	7,088	—	1,300	—	300	1	9	—	13,788
1871	800	—	7,900	2	3,081	850	1,300	—	1,206	60	6	—	15,205
1872	1,202	—	4,810	—	5,038	200	1,000	13	733	100	2	—	13,098
1873	—	—	1,600	44	3,454	26	335	32	105	147	9	—	5,752
1874	315	—	1,200	248	4,104	200	500	21	100	80	2	13	6,770
1875	287	100	18,190	968	5,757	400	2,000	34	1,090	104	17	—	28,960
1876	3,094	650	24,526	427	7,400	825	2,700	205	1,213	64	36	51	41,140
1877	818	—	31,195	377	8,088	575	2,969	77	1,820	—	16	5	45,986
1878	200	—	20,525	705	8,598	200	1,200	98	596	—	25	1	32,152
1879	500	—	36,958	777	10,774	650	1,612	105	1,051	—	10	—	52,438
1880	600	—	19,488	206	11,456	550	640	140	1,509	80	14	—	34,683
1881	400	—	17,006	325	15,141	150	660	58	1,359	151	14	—	35,264
1882	1,100	—	19,451	620	9,738	500	1,480	65	1,795	—	21	1	34,771
1883	3,100	—	16,365	1,218	10,764	170	800	59	760	—	11	—	33,247
Totals	37,771	27,322	338,985	7,024	204,803	18,014	48,165	1,267	19,992	1,574	776	73	705,766

The above statement includes only the shipments by sea. There was no other way of getting the article out of the State prior to 1869. In 1870, shipments began to be made to New York by rail, both from this city and San José. The quantity reported by rail does not include consignments to silver mines in Nevada. Shipments to the Nevada mines before the opening of the railroad were credited to the consumption of California, as there was then no record of such inter-State commerce, any more than there is now. The shipments of quicksilver out of the State by rail from San Francisco and San José, from 1870 to 1883, have been as follows:

Years.	Flasks.	Years.	Flasks.
1870	453	1880	11,646
1871	1,135	1881	10,534
1872	3,651	1882	5,702
1873	4,805	1883	4,640
1874	4,980		
1875	8,892	Total by rail, 14 years	89,246
1876	7,906	By water, 24 years	705,766
1877	6,338		
1878	7,596	By land and water, 24 years	795,012
1879	10,668		

The importance of this trade to California is best shown by the value of the article, which has varied, as before remarked, from $1 55 to 33 cents per pound. Both are extreme figures, and one is as unsatisfactory to the consumers as the other is to producers. One or two companies can probably make something producing the article at a price as low as 33 cents, but that depends, of course, on the existence of especially favorable conditions. The fact that nearly all of the thirty odd claims of this character in the State have been abandoned of late, with prices rating from 33 cents to 36 cents, shows what producers think of the matter, and it is the best evidence that there is no money in the business to them at such prices. At present the article is quoted at $29 per flask, which is equivalent to 37.91 cents per pound. But there is no talk of reopening mines on any such basis, though if 38 cents could be guaranteed right along, some mines would be reopened.

123. REALGAR. Name used by the alchemists. Sulphide of Arsenic.

Color bright red to orange yellow. H.=1.5—2., sp. gr.=3.4—3.6. Wholly volatile B. B. on ch. giving fumes of sulphur and arsenic, burning at the same time with a blue flame. Composition (As S).

Sulphur	29.9
Arsenic	70.1
	100.0

This mineral is rare in California, being known only with arsenolite in Alpine County, but it is very abundant in Washington Territory, east of Seattle, exact locality not given. This deposit is probably the one referred to in "Cleaveland's Elementary Treatise on Mineralogy and Geology," published in 1818, fol. 555, as follows: "On the northwest coast of America, it (orpiment) is mixed with realgar."

Red Oxide of Copper—see Cuprite.

Red Oxide of Iron—see Hematite.

124. RESIN. Fossil.

In the hydraulic gold mines of California a fossil resin is frequently met with, which is probably from the coniferous trees of former growth, found in such profusion in a silicified state. It is brittle and resinous, and still retains an odor. It somewhat resembles gum dammar, but is more yellow. It has never been studied. Represented in the State Museum by No. 4062.

RETINALITE—see Serpentine.

125. RHODONITE. Silicate of Manganese.

Named from its red color, from a Greek word, "the rose." It occurs in several localities in the State, always with pyrolusite; with native copper, Mumford's Hill, Plumas County (Edman); one mile from the Southern Pacific Railroad, between Colton and San Diego; near San José, Santa Clara County; two miles south of Summersville, Tuolumne County, in considerable quantity, No. 3657, State Museum. No. 4088 is from a large deposit of rhodonite and pyrolusite, two miles north of Sonora, Tuolumne County. Rhodonite has little or no economic value.

126. ROCK SOAP.

This is a mineral resembling halloysite and mordenite, but believed to be a mechanical mixture of two or more minerals. It has the remarkable property of removing impurity from the skin, like soap, whence the name. There have been numerous analyses made which do not agree among themselves. A paper was published by Prof. George H. Koenig, in *The Naturalists' Leisure Hours*, Philadelphia, which is very full and explicit, giving the result of considerable laboratory work. A series of analyses were made in the laboratory of the State University, which have not been published. In Prof. Koenig's examination the soapy portion was separated mechanically from a sandy portion and analyzed, with the following results:

Sesquioxides of alumina and iron	14.10
Silica	73.10
Water	6.70
Not determined	6.10
	100.00

Nearly all the silica was found to be in the soluble or opaline state, and the alumina either as a hydrate, or a very basic hydrated silicate. At one time this material was manufactured into a variety of useful articles, as salt water soap (it having been found that the presence of salt and lime did not impair its detergent properties), scrubbing, and toilet soap, and even tooth powder. Having had occasion to examine into the merits of these preparations, I am prepared to say that they served every purpose claimed for them. At the Paris Exposition of 1878 samples were shown which attracted considerable attention, and there were those who expressed an inclination to enter into their manufacture in France. At present "rock soap" is largely used in the manufacture of certain kinds of soap in California. No. 4024, in the State Museum, is a specimen from Ventura County, and No. 4794 is from San Benito County.

127. ROSCOELITE.

This very rare mineral was described in the second annual report, folio 262, and a history given of its discovery, but, as many who receive this report will not be able to refer to the former, I have thought best to insert the whole paper here:

Roscoelite is a new and extremely rare mineral found in El Dorado County, California.

Attention was first called to it by the reading of a paper by Dr. James Blake, at a meeting of the San Francisco Microscopical Society, July 2, 1874. The specimens then exhibited were from a mine or claim, known as the "Stuckslager," "Plum Tree," or "Sam Simms" mine, which lies in Section 24, Township 11 north, and Range 9 east, Mount Diablo base and meridian; somewhat more than a mile from the town of Coloma, in a southwest direction.

At a meeting of the California Academy of Sciences, held on July 20, 1874, Dr. Blake presented specimens of the same mineral, which he then supposed to be a chromium mica, having, in a preliminary examination, found, as he supposed, chromic acid combined with silica, potash, and lithium. Gold was also associated with the mineral in considerable quantities. He stated that it was found at Granite Creek, near Coloma, El Dorado County, remarking at the same time that the associated minerals were an interesting and beautiful microscopic study, and that the formation indicated that the gold must have been deposited between the flakes of the mica from an aqueous solution. He gave the new mineral the provisional name of "*Colomite*," from the locality.

The next notice appears in the proceedings of the California Academy of Sciences, Vol. 6, 1875, folio 150. At a meeting held August second of that year, Dr. Blake read a paper on "*Roscoelite*," a new mineral, in which he admitted that he had stated at a former meeting that the mineral contained a large quantity of chromic acid, an opinion derived from the results of superficial blowpipe tests. He had since sent samples to Dr. Genth, of Philadelphia, who found it to contain vanadium. He had given the name *Roscoelite* as a compliment to Prof. Roscoe, of Manchester, England, who has made vanadium a special study. In a foot-note, Dr. Blake expresses the opinion that vanadium may occur in these rocks in larger quantities than is generally supposed; and calls attention to the fact that Dr. Hall has found it widely diffused in many rocks.

The vein from which the roscoelite was taken is small and not continuous, varying from two inches to a foot in thickness, running nearly parallel with Granite Creek.

The quartz is ferruginous in appearance, and is associated with calcite and slaty matter, and at least two varieties of pyrites. Gold occurs only with the roscoelite, and usually in parts of the vein where the quartz disappears or "pinches out," as the miners express it.

Roscoelite was for a long time a mystery to the miners, and was first mistaken for plumbago. The pioneer placer miners at Big Red Ravine used to complain of the difficulty of saving the gold, owing to the interference of the "black stuff," as they designated it. In all probability, a large quantity of gold was allowed to escape from ignorance of the nature of this mineral.

Gold is found interstratified with laminæ of roscoelite, or imbedded in it, in pieces from the value of one dollar to the minutest microscopic particles.

The method of operation at the mine has been to remove superficial slaty covering by ground sluicing, and carefully working the small but exceedingly rich material found in the pay-seam. From one pan of this, 40 ounces of gold has been taken; from another, gold to the value of $100 was obtained. The fineness of the gold is .846.

Under the microscope, roscoelite is seen to be in scales and radiated tufts, the luster of which is silvery or pearly to a high degree—almost metallic by strong reflected light; color, light steel gray, yellowish dark green, or nearly black, as seen in different lights. Small deeply striated crystals of white iron pyrites are sometimes seen on freshly broken surfaces of quartz, partly imbedded. The quartz in actual contact with roscoelite is generally transparent and nearly colorless; sometimes rose-colored or amethystine. Although rather common in the ores, pyrites has not been observed in contact with roscoelite.

When magnified 70 diameters, roscoelite resembles the variety of pyrophyllite found at Greaser Gulch, Mariposa County. As far as observed, the associated gold is always bright, of good color and amorphous, generally rounded as if water-worn.

The other mineral associates of roscoelite are calcite, and a yellow mineral, which is probably marcasite or chalcopyrite, found only in microscopic quantities.

The only other known locality of roscoelite in the State, is Section 31, Township 11 north, and Range 10 east, two miles from the Sam Simms mine. Big Red Ravine is on this section, lying only two miles from the site of Sutter's mill, where gold was first discovered. It was one of the earliest placer mines known in the State, and so rich did it prove, that it has paid to rework as many as seven times. It is in the bedrock of these old workings that roscoelite is found.

I am indebted to Mr. George W. Kimble, surveyor of El Dorado County, for valuable information and for specimens of this rare and interesting mineral—with him I walked over the ground while he pointed out the localities. The largest mass found here was taken out by a Chinaman and is described as having been as large as a gallon measure. From first to last 400 to 500 pounds of roscoelite have been obtained, all of which was wasted in extracting the gold.

I was only able to obtain for the State Museum a thin piece of quartz of a few inches superficial surface, coated on both sides with roscoelite; some large masses showing the mineral in spots, and some beautiful microscopical specimens containing gold.

At the Red Ravine locality, roscoelite is found in a dark colored bluish micaceous rock in small seams of quartz and calcite with gold. This rock has not yet been studied.

Through the politeness of Mr. James Taylor, of Owen's College, Manchester, England, I have been furnished with the following analysis of roscoelite.

Analysis of roscoelite by Prof. H. E. Roscoe, of Owen's College, Manchester, England:

Silica	41.25
Vanadic acid (V, 2; O, 5)	28.60
Alumina	12.84
Sesquioxide of iron	1.13
Oxide of manganese (Mn., 3; O, 4)	1.10

Lime	.61
Magnesia	2.01
Potash	8.56
Soda	.82
Water combined	1.08
Moisture	2.27
Total	100.27

The following is quoted from a paper, published in 1877, by Professor F. A. Genth, "On Some Tellurium and Vanadium Minerals," contributions from the laboratory of the University of Pennsylvania:

ROSCOELITE.

It will be remembered that almost simultaneously Professor H. E. Roscoe and I investigated the mineral which now bears his name, his paper having been received by the Royal Society, on May 10, 1876, (Proceedings Royal Society, XXV, 109,) whilst mine was written and sent to the editors of the *American Journal of Science,* on May 16, 1876.

I regret that in some of the essential points our results do not agree.

From the nature of the material and the information received from Dr. James Blake, of San Francisco, no doubt can exist that that which he had sent to me was as good and pure as could be obtained. In my examination (*American Journal of Science,* 3, *XII,* 32), I showed that even the apparently purest scales, selected with the greatest pains, were not altogether free from admixtures. With the greatest difficulty I obtained enough of almost pure scales (containing only 0.85 per cent of quartz, gold, etc.) to make one analysis, which, as it was made with the greatest care, must be a very close approximation of the truth. The material of the other analysis was far more contaminated, and the results were given merely for comparison, and to show the influence of the admixtures upon the analysis.

From Prof. Roscoe's analyses it does not appear that he attempted to separate the impurities by chemical means, and thus he gives the composition of the whole mixture.

He assumes the vanadium to be present as pentoxide, the iron as ferric oxide, the manganese as manganic oxide, the two latter as replacing alumina; and magnesia, lime, and soda as replacing potassium oxide.

As I have made a direct determination of the state of oxidation of the vanadium, I can say *positively* that, if any, only the smaller portion of the vanadium is pentoxide. I found the composition of the vanadium oxide to be $V_6O_{11}=2\ V_2O_3,\ V_2O_5$; but as it was obtained after allowing for the oxidation of ferrous into ferric oxide, and as the quantities of ferrous oxide have been found to vary from 1.67 to 3.30 per cent, it is not impossible that an insufficient quantity of oxygen has been deducted, and that the whole of the vanadium is present as V_2O_3.

Pure roscoelite contains no manganese; in Prof. Roscoe's analyses 0.85—1.45 per cent of manganic oxide have been found, which confirms my opinion that his material was not pure; but what is most astonishing to me is the very low percentage of silica which he finds.

From his analyses he calculates a formula, and from this the percentage composition, which, however, is far from corresponding with his analyses, as for instance:

Silica found	41.25, calculated, 41.18
Potassium oxide found	8.56, calculated, 14.24

I had not calculated any formula from my analyses, being in hope that I may yet be able to procure this interesting mineral in a still purer state for further investigation. For comparison I will insert my analysis (*a*) which certainly closely represents the true composition of roscoelite, and will add the formula corresponding with the same, with this alteration, however, that I consider all the vanadium as V_2O_3. It contains, after deducting 0.85 per cent of quartz, gold, etc.:

	Found.	Calculated.
SiO_2	47.69	49.33
Al_2O_3	14.10	14.09
V_2O_3	20.56	20.62
FeO	1.67	1.64
MgO	2.00	1.83
Li_2O	Trace.	----------
Na_2O	0.19	----------
K_2O	7.59	7.55
Ignition	4.96	4.94
	98.76	100.00

The analysis agrees with the formula:

$$\overset{I}{R}_2 \overset{II}{R} \overset{VI}{R}_2 Si_{12} O_{32} + 4 H_2O$$

$$\overset{I}{R} = K$$

$$\overset{II}{R} = Mg : Fe = 2 : 1$$

$$\overset{VI}{R} = Al : V = 1 : 1$$

or, $K_2 (MgFe) (Al\,V)_2 Si_{12} O_{32}$
as will be seen from the calculated per cent.

From my repeated examination of the mineral microscopically, I am convinced that it would be extremely difficult to obtain sufficient roscoelite for a chemical analysis, perfectly free from admixture.

Since the publication of the second annual report, a fine specimen of roscoelite has been presented to the State Museum, which is mixed with gold to the extent of seemingly half the bulk of the specimen. It was presented by Richard Sparling, and is numbered (5768). It is from the Tip Top vein, Section 7, Township 11 north, Range 10 east, El Dorado County. There is about a foot of quartz disseminated through the vein, in small bunches, connected with which are seams of roscoelite, generally very thin, from the thickness of paper to half an inch. Occasionally a bunch of roscoelite appears, from which specimens like No. 5768 may be obtained, but these are extremely rare. Mr. Sparling says that at the Sam Simms mine, the owners once took out of a pocket $11,000. A great deal of free gold has been washed from the sides of the hill, below the vein, which came, without much doubt, from decomposed roscoelite, and it is more than probable that the gold discovered at Sutter's mill, in 1848, and that taken from Big Red Ravine, were from the same source. In the Tip Top there is a sheet of what seems to be sandstone; when this and the brown slate come in contact, gold and roscoelite are found.

RUBELLITE—see Tourmaline.

RUBY SILVER—see Pyrargyrite and Proustite.

128. RUTILE. *Rutilus*, Red (Latin). Titanic Acid.

Is found at Long Valley, Plumas County (Edman); and frequently in acicular or capillary crystals in quartz. No. 3747 is a specimen of this character from Humboldt County, Nevada, and there are other specimens in the Museum from other localities. Titanic acid has few applications in the arts; it is used in porcelain painting, and to give color to artificial teeth.

129. SALT. Halite.

The manufacture of salt in California was described in the second report of the State Mineralogist, 1882, folio 217, and locations of known salt beds, salt shipped, etc., given.

The condition of this industry has not greatly changed within the past two years. The most notable feature of the business developed during this period, is the largely increased product of domestic salt, due mainly to the extended operations of the Union Salt Company. Prices have ruled low by reason of the market being heavily stocked. In the early part of 1883, Liverpool salt, from ship, sold as low as $11 50 per ton, but afterwards advanced to $15. The price in San

Francisco varies now from $6 to $23 per ton, the latter for the best table salt. What tends to keep prices depressed is the low rates at which this commodity can be brought to this port by ships coming here to load with wheat, invoices selling very often for barely enough to pay freight and charges.

The quantities of salt supplied to this market and the sources whence obtained, are shown by the following statement:

Imports.	1880.	1881.	1882.	1883.
English, pounds	13,828,066	7,746,408	12,841,212	8,543,878
Carmen Island, pounds	3,542,000	2,730,000	761,600	21,046
Peru, pounds	----------	----------	1,200,000	----------
Receipts, California, tons	9,397	13,275	14,395	21,039

To the receipts of California salt at San Francisco, as above denoted, there should be added about 9,000 tons made in the State, but not sent to the city, it having been shipped directly from the works to other markets and points of consumption. The total product of California in 1883 may be set down, therefore, at about 30,000 tons, being the largest by one third made in any one year in the history of this industry. As will be seen by reference to the above statement, while the home product has been so increased, imports have been diminished in a corresponding ratio; importations from Liverpool in 1883, as compared with those of 1882, having fallen off about one third; the disparity in importations of Mexican salt for these two years having been much greater, while in the case of Peru they ceased altogether.

The rate at which this business has grown in California is indicated by the following table:

	1860.	1870.	1880.
Bushels made	44,000	174,855	884,443
Value	$7,100	$48,150	$121,250
Wages paid	$5,400	$13,400	$49,120

At no time since it was commenced has this business advanced more rapidly than during the past three years, the quality of the article turned out having meantime undergone much improvement. At one time none of the California made salt was considered fit for meat packing or dairy use; now, much of it is employed for these purposes, being little, if at all, inferior to the best Liverpool.

The capital invested in the salt business in California approximates now half a million dollars—number of men employed during the active season, three hundred; value of yearly product, $300,000; wages paid out, $70,000. The Union Salt Company, the largest producers in the State, have increased the capacity of their works of late to the extent of two thousand tons per year, some of the other Bay companies having also enlarged their works somewhat. A well near Yreka, Siskiyou County, bored to a depth of 675 feet, is said to discharge ten thousand gallons of salt water per hour, from which salt is being produced by graduation, thus described in the second annual report:

"In climates less temperate, or unsuited for rapid evaporation, the weak brines, or sea water, are first subjected to a process called 'graduation.' Large buildings are constructed, open at the sides, from thirty to forty feet high, eighteen to twenty-five feet wide, and sometimes two thousand feet long. The building is set at right angles with the prevailing winds. The floor consists of a basin of concrete or hydraulic cement, with walls three feet high. In this basin is piled an immense mass of faggots of oblong shape, and somewhat smaller in size than the building. The brines are pumped up into shallow wooden pans or troughs, overlying the pile of brushwood. The troughs are pierced with a multitude of small holes through which the brines percolate in small streams.

"As the liquid trickles down through the brushwood, it is exposed to the air in thin strata, and becomes rapidly concentrated. It sometimes requires to be pumped three times before it attains the density of twenty-five degrees Beaumé, when it is run into crystallizing vats. This operation, indispensable in some climates, and under some conditions, is unnecessary on the shores of San Francisco Bay, where the air is dry during a great portion of the year, during which no rain falls to interfere with the evaporation, and where extensive salt marshes afford ample room for salt gardens.

"Sulphate of lime forms on the faggots as an incrustation, which, in time—from five to eight years—so fills the interstices that the pile becomes worthless, and must be replaced by another. The graduation process is not new. In 1812, Thompson, in his travels in Sweden, saw, at the copper mines at Fahlun, natural solutions of sulphate of iron (from which the copper had been precipitated by scrap iron), concentrated in this manner. On pumping the extremely dilute solution up seven times, it had nearly reached the point of crystallization, when it was conducted into suitable lead-lined pans, in which it was evaporated by heat to the required density and run into crystallizing vats.

"This economical method of concentration might be practiced to advantage in various metallurgical operations in California, and the pumping done by large windmills built and managed on the Dutch plan.

"A more detailed description of graduation may be found in Lippincott's Encyclopædia of Chemistry, volume 2, folio 733, with an engraving showing mode of construction in Precis de Chimie, by L. Troost, Paris, 1873."

A NEW ENTERPRISE.

During the past year, a new enterprise directed to the production of salt in California has been set on foot, the site of this undertaking being the extensive saline near Dos Palmas, a station on the Southern Pacific Railroad, in San Diego County, and distant 135 miles southeast from the city of Los Angeles. The saliniferous deposits at this point, occupy the dry bed of an ancient inland sea or lake, and consist of layers of crystallized salt, interstratified with thin seams of clay and sand, the salt bed here resembling, in this respect, others found in southeastern California, also in Arizona, Utah, and Nevada. Digging down through this mass, three fourths of which consists of salt, to a depth varying from five to ten feet, a supersaturated brine is encountered, which, entering the excavation, soon fills it with a solid mass of salt, so rapidly does evaporation go on in this hot and arid climate. Salt can, of course, be produced here very cheaply, nothing more being required than to shovel up this material on a wooden platform, and there leave it to drain for a few hours, when it is ready for sacking and shipping. Where an absolutely pure article is required, salt will be produced by evaporating the brine, which can be effected readily without recourse to artificial heat, the temperature of this *sink*, which is 265 feet below sea level, ranging from 100 to 130 degrees for seven or eight months in the year.

This is the region described under the head of "Mud Volcanoes and Colorado Desert," folio 227, of the second annual report. At the sink of this desert basin, the Liverpool Salt Company of California have put up the necessary plant for producing this staple on a large scale, a railroad, two miles in length, having recently been completed, connecting their works with the Southern Pacific track at Dos Palmas. This company is now in successful operation, supplying the product of their works to Southern California and Western Arizona, a trade which their geographical position will enable them to always command. An analysis of this salt recently made, is said to have given the following results:

Chloride of sodium	97.76
Sulphate of sodium	.70
Chloride of iodine	.27
Moisture	.96
Insoluble matter	.20
	99.89

130. SASSOLITE.

Native boracic acid is known to the mineralogist as Sassolite, or Sassoline, named from Sasso, in Italy, where it was first found in a solid state by Mascagni. It occurs also abundantly in the extinct crater of a volcano in one of the Lipari Islands, near Sicily, as mentioned elsewhere, at which locality it was discovered in 1813 by Dr. Holland. It is found, also, in crevices and fissures in the craters of active volcanoes. During the eruption of Vesuvius, in 1851, this mineral was deposited in fissures in Torre Del Greco. It has been obtained, also, from the crater of Stromboli, an active volcano on an island of the same name, one of the Lipari group. It exists, also, in solution in mineral waters of Germany and elsewhere, notably Wiesbaden, Aachen, and Krankenheil.

Boracic acid, free or combined, is of common occurrence on the Pacific Coast. It has been detected in the waters of the ocean along the shores of California and Oregon. Common salt, made by evaporating the sea-water, contains more than traces of boracic acid. According to Professor W. P. Blake, it occurs in a free state in the water of Clear Lake. The discovery of this acid in mineral water in Tehama County led to the examination of other springs then known, which resulted in the finding of boracic acid in nearly all of them. It was discovered at the mud volcanoes in San Diego County by Dr. Veatch, which was verified by my own observation.

Sassolite, of the books, is said to crystallize, in the triclinic system, but all the specimens I have seen show under the microscope a confusion of broken scales without any well defined crystals. When magnified it has almost exactly the appearance of selenite, with the same apparent cleavage and pearly luster. When closely examined, obscure hexagonal plates, imbedded in the pearly mass, may sometimes be distinguished.

Sassolite fuses easily, coloring the blowpipe flame at the same time transiently green; gives water in a closed glass tube; color, white-yellowish, and sometimes a dirty brown; hardness, 1 to 1.48: chemical formula, BO_3+3HO.

PERCENTAGE COMPOSITION.

Boracic acid	56.45
Water	43.55
	100.00

Satin Spar—see Gypsum.

131. SCHEELITE. See also Cuproscheelite.

This mineral is named after the Swedish chemist, Scheele. It is a tungstate of lime ($Ca\,O\,W\,O_3$), consisting of:

Tungstic acid	80.6
Lime	19.4
	100.0

H=4—4.5, sp. gr.=5.9—6. Color, from pale yellow or nearly white to orange yellow, sometimes light shades of brown, green, or red; luster, vitreous; streak, white; brittle, B. B. in forceps, fuses somewhat difficultly, soluble in borax to a transparent glass, which becomes opaque on cooling; decomposed by boiling hydrochloric acid.

Only one locality is known in the State. 4055 is from the footwall of a gold mine on Howard Hill, Grass Valley, Nevada County, where it is said to occur in considerable quantity.

The color of this mineral is yellow, streak lighter, B. B., fusible, with intumescence. In hydrochloric acid it is decomposed, leaving a residue of tungstic acid; the acid solution with metallic zinc takes a deep blue color, and gives reactions for lime and iron. Under the microscope the mineral shows the vitreous luster of scheelite, which is obscure to the unassisted eye. Tungistic acid, which can be cheaply made from this mineral, has certain uses in the arts, among the most important of which is the preparation of incombustible cloth. Dresses and theatrical scenery dipped in a solution of tungstate of soda and dried, will not ignite when brought in contact with flame. In England and other countries, light muslin dresses and draperies are treated with tungstate of soda in laundries. Tungstate of soda is also used for setting colors in calico printing. Tungtate of lead is sometimes substituted for white lead in painting, and tungstic acid, which is oxide of tungsten, is employed in coloring yellow.

Schorl—see Tourmaline.

Selenite—see Gypsum.

Semi-Opal—see Quartz.

132. SEPIOLITE. Meerschaum, Hydrous Silicate of Magnesia.

No. 4263 in the State Museum, from the Half Dollar mine, Inyo County, resembles sepiolite, but as yet no analysis has been made to determine it.

133. SERPENTINE. Chryotile, Picrolite, Retinalite.

So called from its resemblance to the skin of a serpent, is found in such large masses or beds that it is also classed with the rocks. These rocks are metamorphic, not eruptive as formerly supposed, and it is believed that the original mineral was olivine. It is a granular or compact rock occurring in irregular rather oval shaped masses in schistose rocks, or in distinct dikes or veins intersecting other rocks. The prevailing color is a dirty green, but it is found also nearly black, to golden or honey-yellow, as retinalite (or precious serpentine), and some varieties are mottled and shining. Prof. Hunt thinks it may have been a sedimentary deposit from sea water. Altogether serpentine is a very interesting rock, and affords a wide field for the investigations of lithologists. Serpentines contain included in them, several characteristic and important minerals, as chromic iron, olivine, enstatite, and magnetite. Chrysotile, which is found intersecting serpentines in fibrous silky sheets, is a variety of serpentine. When intermingled with dolomite, magnesite, or calcite, serpentine becomes ophiolite, or verde antique. Serpentine cut into slabs is called serpentine marble (see building stones).

It is very common and abundant in California. The following localities are represented in the State Museum: (8.) With microscopic section. (4722.) Peninsula of San Francisco. (488 and 512.) Bear Valley, Mariposa County. (513.) Three hundred yards northeast of the Pine Tree mine, same locality. (544 and 555.) Fort Point, San Francisco County. (580.) Yuba County. (1270 and 1271.) With aragonite. Corner of Market and Guerrero Streets, San Francisco. (1318.) Market Street cut, near Guerrero Street, San Francisco. (1439.) Maryland mine, Grass Valley, Nevada County. (1540 and 1539.) Polished. Lone Mountain cemetery, San Francisco. (1724.) Schistose. New Almaden quicksilver mine, Santa Clara County. (2121.) Yuba River, Nevada County. (2778.) Polished specimen. Kelseyville, Lake County. (3415.) Bald Prairie, Placer County. (4087.) Serpentine rocks. Goleta, Santa Barbara County. (4146.) Monterey, Monterey County. (4960.) Near Red Hill, Butte County. Serpentine is also found on Claremont Hill, Plumas County (Edman); at Pine Grove, Cloverdale, Sonoma County; at Gilroy, Santa Clara County; Corral de Tierra, Monterey County; McCloud River, Shasta County; with cinnabar, in the 1,400 foot level of the New Almaden quicksilver mine, 30 feet from hanging wall, Santa Clara County; and elsewhere in the State. Retinalite occurs, green and translucent, at Meadow Valley, Plumas County (Edman); also in Napa County; and in beautiful specimens, with chrysotile, on the McCloud River, Shasta County.

Sesquicarbonate of Soda—see Trona.

134. SIDERITE. Named from the Latin word for Loadstone, or Magnet. Spathic Iron, Carbonate of Iron. (FeO, CO_2.)

Carbonic acid	37.9
Protoxide of iron	62.1
	100.0

This mineral has recently been found by J. W. Redway, in quartz ledges in Tejunga Cañon, Los Angeles County, and is represented in the State Museum by No. 3712.

SILICIFIED WOOD—see Quartz.

SILICATE OF COPPER—see Chrysocolla.

135. SILVER.

CHEMICAL AND PHYSICAL PROPERTIES.

Silver is the most beautiful and the brightest of metals. Its pure white color, luster, tenacity, malleability, the facility with which it can be melted and cast into any desired shape, and its permanency, are properties which have made it a favorite metal from the earliest times.

It is one of the *noble metals*, by which is meant that it is permanent under ordinary external influences, and having but little affinity for oxygen, retains its luster.

These properties and its comparative scarcity are the reasons why it is classed among the precious metals.

Silver is one of the few metals which occur in nature in a metallic state, and for this reason was among the earliest known. When native, it is found crystallized in the first system, generally in cubes and octahedrons; sometimes in dendritic, fern-like shapes, which, on closer examination, may be seen to be strings of cubes or octahedrons, which are very beautiful under the microscope. It frequently occurs in fibers called "wire silver." These threads are striated, as if pushed out through small orifices in the rock while in a semi-fluid state, and are generally curved.

Although sometimes nearly pure, native silver is generally alloyed with gold, antimony, arsenic, etc.

Silver, although comparatively rare, is found distributed over a large portion of the earth's surface; seldom metallic, often in distinct silver minerals; still more frequently associated with other metals; sometimes alloyed with gold, as "electrum;" at Lake Superior with native copper, not alloyed, but joined to the copper as if precipitated by it from solution; rarely in masses, like placer gold; scarcely without exception in galena and other lead minerals. It is generally extracted from ores which take many complex forms. Much of the silver of commerce is derived from lead, with which it is always associated in greater or less quantities.

Pure silver is very malleable, but not so much so as gold; its specific gravity is 10.47; it melts at 1860 Fahrenheit; crystallizes readily when cooled slowly. The atomic weight of silver is 108, and its chemical symbol (Ag), from argentum, the Latin name of the metal. The alchemists called silver after the moon, "*luna*," from which the name of the nitrate, "*lunar caustic*," is derived.

It dissolves readily in rather dilute nitric acid, but is scarcely acted upon by hydrochloric or dilute sulphuric acids. Hydro-sulphuric acid and sulphide of ammonium precipitate it from its solutions as a black sulphide of silver (AgS). Boiling nitric acid decomposes this precipitate with separation of sulphur. Soda and potassa precipitate from solutions of silver the oxide of that metal, which is insoluble in excess of the precipitant, but dissolves in ammonia. Ammonia also precipitates the oxide from neutral solutions, which readily dissolve in excess. Hydrochloric acid and soluble chlorides precipitate silver as a white curdy chloride of silver ($AgCl$), which is insoluble in acids, but dissolves in ammonia, from which it is again precipitated unchanged by acids. By exposure to heat chloride of silver fuses to a transparent horny mass. When this compound is found in nature it is sometimes called "horn silver." This mineral is found in California, and is described under the name of cerargyrite.

SILVER MINERALS.

The following is a list of the silver minerals, with the percentage of silver in each. Only those printed in capitals have an economic value. The others are of rare occurrence, and are found in quantities too small to be considered here, except for their scientific interest. Those marked with an asterisk have been found in California:

1. Rittingerite	——	*14. PYRARGYRITE	59.8
*2. GALENITE—variable.		*15. EMBOLITE	61.07, 71.94
*3. Sylvanite	3.9, 14.68	16. Pyrostilpnite	62.3
*4. TETRAHEDRITE	——	*17. Hessite	62.8
—. FREIBERGITE	3.9, 31.29	18. Xanthoconite	64.0
5. Styloptypite	8.0	*19. PROUSTITE	64.67
6. FREIESLEBENITE	24.3	*20. STEPHANITE	68.5
7. Brogniardite	26.1	21. Naumannite	73.2
8. Sternbergite	33.2	*22. CERARGYRITE	75.3
9. MIARGYRITE	36.0	*23. POLYBASITE	75.5
10. Eucairite	43.1	24. Dyscrasite	78.0
11. Iodyrite	46.0	25. Chilenite	86.2
*12. STROMEYRITE	53.1	*26. ARGENTITE	87.1
13. Bromyrite	57.4	*27. NATIVE SILVER—nearly pure.	

All compounds of silver, when mixed with carbonate of soda, give in the inner flame of the blowpipe, *brilliant, white, ductile, metallic* globules, which make no incrustation on charcoal, unless the heat is too long continued, when a slight red sublimate is formed. By these reactions silver may be distinguished from all other metals.

One grain of silver is worth	$0.0026936
One gram	0.0415622
One troy ounce	1.292929+
One pound avoirdupois	18.85+
One ton (2,000 lbs.)	37,700.00
One cubic inch	7.14
One cubic foot	12,337.92

ASSAY OF SILVER AND GOLD.

Silver ores so generally contain gold that both metals are included in the silver assay. The assay may be made by fusion in crucibles, with the proper fluxes, or by *scorification.* Many assayers consider the crucible assay the best, but experience has convinced me that scorification gives the most correct results, always supposing the operator to be a skillful manipulator. To allow the reader an opportunity to practice both, both methods will be given in detail:

CRUCIBLE ASSAY.

Before a crucible assay can be properly made, the ore, if containing sulphur, must be roasted, and if not already fine it must be pulverized and sifted. A mechanical loss of the precious metals may occur in roasting unless the greatest care is taken in the manipulation, and if the temperature is too high. During the stirring which is necessary, there is danger of small portions of the ore being thrown over the side of the vessel and lost. This loss should be carefully guarded against.

To determine if a sample of ore contains sulphur, it is only necessary to throw a small portion of its powder on a piece of red-hot iron. If that element is present, the smell of burning sulphur will be perceptible; otherwise the operation of roasting may be dispensed with.

The amount taken for assay depends on the supposed richness of the ore. If very rich, 10 grams, or even 5 may suffice; but ordinarily $29\frac{166}{1000}$ grams, or 29.166 milligrams, for convenience of calculation. This weight being taken, each milligram of silver or gold obtained will be equal to one troy ounce of metal in the ton of 2000 pounds, because one pound avoirdupois is equal to 14.5833+ troy ounces; therefore, $14.58333+\times 2000=29166$. This weight is called the "assay ton," as in all ore assays the returns are made in troy ounces, it is found convenient to employ this unit as the basis for all ore assays. This unit was first proposed, I believe, by Professor Chandler of New York, and is now generally adopted by American assayers.

The weight of the pulverized ore is carefully transferred to a shallow dish of burned clay—a scorifier being suitable if it is to be roasted—and placed in the mouth of a hot muffle, where the heat is not too great. The vessel must be frequently turned until all the water has been expelled. The scorifier must then be pushed forward to a point where the heat is greater. When fumes begin to pass off, the assay must be stirred. This is done with a piece of bent iron wire, one end of which is fixed into a wooden handle.

If the heat is raised too suddenly, the assay is likely to partially fuse, in which case perfect roasting is impossible unless the scorifier be removed and the contents cooled and pulverized before making a second attempt, but as a loss by such treatment is nearly certain, it is better to weigh out a new charge and make a second trial with more care.

As the roasting progresses, the assay becomes less and less fusible and may be gradually pushed back to the hottest part of the muffle, until it has attained a red heat and no more fumes or odor are given off.

The assay is then removed from the muffle, allowed to cool, and transferred to a good Hessian or French crucible. Fifty grams of litharge, its own weight of borax, about one gram of argol or charcoal, and a mixing spoonful each of carbonate of soda and carbonate of potash, are put into the crucible with it, and the whole stirred thoroughly with the mixing spoon. The crucible must then be tapped against the table to cause the charge to settle.

To insure the elimination of any sulphur that might escape observation or remain in the ore from imperfect roasting, three large nails are pushed head downward until they nearly or quite reach the bottom of the crucible.

The surface of the charge is then covered evenly with common salt. Upon this are to be placed several lumps of borax; the crucible is then ready for the fire. Two crucibles should be prepared in this manner.

For the fusions a very strong fire will be required. The crucibles may be placed in such position that they cannot fall over, and hot coals are then built up around them. When the contents begin to fuse, a cover is placed upon each crucible and the draft of the furnace so arranged that the greatest heat may be produced. After a few minutes the cover of one of the crucibles must be lifted and the action of the heat on its contents observed. If the charge has melted down and is in a quiet state of fusion, both covers may be removed and that condition maintained for five or ten minutes more. If such is not the case, the cover must be replaced and more time given. It is necessary that perfect fusion should be effected to insure accurate results. When the contents of each are perfectly fluid and intensely hot, the crucibles may be removed, and after tapping against the side of the furnace to cause all particles of lead to gravitate to the bottom, the nails are then removed by seizure, each one in succession with the tongs, and by stirring them about in the liquid flux, wash away, so to speak, the metallic globules that may be attached to them. The crucibles are tapped again and set aside to cool. When cold the crucibles are broken, and the buttons of lead hammered into cubes and cleaned preparatory to cupellation.

When an alloy of lead and silver or gold, or both, is placed in a small cup of bone ashes and exposed to the intense heat of a muffle through which a current of air is caused to pass by the draft of the chimney, the lead first melts, then oxidizes and is absorbed by the bone ashes. This continues until the noble metals are left isolated and pure in the muffle. The cup is called a cupel and the operation cupellation.

The litharge used in mixing the assay becomes metallic lead in the crucible, gathering at the same time the gold and silver in the ore, for which melted lead has a special affinity. The litharge nearly always contains silver; this must be deducted from the assay. The quantity may be known by making exactly the same assay as described above, but using no ore. All the silver obtained by cupellation must, in that case, come from the litharge. Its weight must be noted and deducted from assays as long as the same litharge is used.

After cupellation the next step is to weigh the bead left on the cupel, and to calculate the results. As the bead probably contains gold it will be necessary to separate that metal, and calculate its value also. To do this proceed as follows:

Suppose the bead should be found to weigh 136 milligrams, note the weight, and then place it in a clean test tube, and boil it with pure nitric acid. If no gold is present, it will wholly dissolve. The calculation may then be made on silver alone; the result will be 136 troy ounces to the ton of two thousand pounds. If a black powder remains, fill the tube with distilled water, pour it off carefully, without disturbing the residue; repeat this two or three times; fill the tube again *full* of distilled water; place a *dry cup*, like a cap, over the tube, reverse both; allow the gold to settle in the cup, remove the test tube, by slowly raising it; pour the water in the cup carefully off; dry the gold in the cup, by placing it in the front of the muffle; heat to redness in the muffle; brush out the now bright gold into the pan of the balance, and weigh. Suppose the gold to weigh three milligrams, then:

Weight of silver and gold	136
Weight of gold	3
Weight of silver	133

As each milligram is equal to one troy ounce in a ton of two thousand pounds, the ore is found to contain per ton:

Silver	133 ounces.
Gold	3 ounces.
	136

If it is desired to give a money value to the ore, the following table may be used. The manner of pointing off in similar tables has been given under the head of "bullion assay of gold."

VALUE OF GOLD AND SILVER BULLION IN OUNCES TROY, AND DECIMALS.

Silver.		*Gold.*	
1	$1 29.29	1	$20 67.18
2	2 58.58	2	41 34.36
3	3 87.87	3	62 01.54
4	5 17.17	4	82 68.72
5	6 46.46	5	103 35.90
6	7 75.75	6	124 03.08
7	9 05.05	7	144 70.26
8	10 34.34	8	165 37.44
9	11 63.63	9	186 04.62

Value of the Silver.

100 ounces silver	$129 29
30 ounces silver	38 78
3 ounces silver	3 87
133	$171 94

Value of the Gold.

3 ounces gold	$62 01

Total value per ton of 2,000.

Silver	$171 94
Gold	62 01
	$233 95

ASSAY OF SILVER BY SCORIFICATION.

The scorification assay is made without previous roasting, unless the sample is concentrated sulphurets, in which case it may be roasted in the scorifier as described under crucible assay. The only reagents used are test lead and dry pulverized borax. The ore is mixed with these and fused in the muffle. I generally use for a charge a quarter of the *assay ton*, which is 7.291 grams. If four scorifications are made, the amount of ore treated will be 29.166 grams, which is the same quantity used in the crucible assay.

In mixing the assay, I use a wooden mustard spoon which holds about eight grams of test lead. This spoon has a hemispherical cavity of a little less than half an inch in depth, and a level rim. With a strip of window glass or a knife blade the superfluous lead may be *struck* off, leaving a uniform quantity in the spoon. Previous to commencing scorification, a careful assay of the test lead must be made by cupelling several spoonfuls in separate cupels, accurately weighing the resulting buttons of silver, which must be dissolved in acid. If any gold remains, the lead is unfit for use, and it should be removed from the laboratory, lest it should be inadvertently used in the future. All lead contains silver, but should never be used for assaying if four of these spoonfuls contain more than one milligram. Knowing the amount of silver contained in one spoonful, and keeping a memorandum of the number of spoonfuls used, it will be easy to make the proper deduction at the time of calculating the final results.

Having weighed out four charges of ore, and transferred them carefully to the same number of scorifiers, four spoonfuls of test lead and one of borax are added to each. A sheet of writing paper is then laid on the mixing table, and the scorifiers placed upon it one by one while being mixed. This precaution is taken to prevent loss by portions being thrown out during stirring.

The mixing is done with a piece of sheet-iron four inches long and half an inch wide, or with a small steel spätula. The scorifiers are then ready for the furnace. Several may be placed in the muffle at once. At first the assay is placed in the mouth of the muffle and allowed to heat gradually. When the first action of the heat upon the borax has subsided and beads of lead are seen to form, the scorifier is pushed back to the hottest part of the muffle, and a second one introduced in front. This is repeated until they are all in, or the muffle is full. The door of the muffle is then closed for a time, until the charges have fully fused. The scorifiers are then removed one by one, and while tightly grasped with the tongs, a strong horizontal rotary motion is imparted to them, causing the slaggy covering to break and attach itself to the sides of the vessel, leaving a circular bare spot on the surface of the molten lead. This effected, they are replaced in the muffle, which is not again closed, but the draft of the furnace checked by shutting the lower door, which causes a steady current of air to pass into the muffle, sweeping over the assay and through the small openings, escaping up the flue. Scorification now commences; the borax causes the slag to become liquid. The oxide of lead is seen to form on the surface of the lead bath, moving with a play of colors to the ring of slag, which becomes more and more fluid as the operation progresses. Every particle of gold or silver passes to the lead and becomes alloyed with it.

After a time the slag—from the formation of litharge—becomes so voluminous as to nearly cover the lead. When this is the case, the lower draft is opened, the muffle door closed and the heat raised, to effect perfect fusion of the assays, which are then withdrawn by the aid of the tongs, and poured out into an iron mold, made expressly for that purpose. When cold, the scorifier is broken, and the lead buttons hammered into cubes and cupelled.

Sometimes, but not often, scorification assays work badly, and require more test lead, or more borax. Experience soon teaches the proper addition to make. In either case, a spoonful is wrapped in paper and placed in the hot scorifier by means of a pair of cupel tongs. If more *lead* is added, a memorandum to that effect must be made, and the known quantity of silver it contains deducted. The calculation is the same as described under the head of crucible assay.

BLOWPIPE ASSAY.

Silver assays can be made to advantage with the blowpipe. This assay has the advantage of being simple, and when once understood, is expeditious and accurate; but cannot be explained without engravings of the apparatus used, for which reason it will not be described here. But I would advise prospectors to obtain books and practice this mode of assay. The best work I know of is the "Treatise on the Use of the Blowpipe," by Plattner, translated by Muspratt. This work will give all the information, practical and theoretical, that may be required.

SILVER IN CALIFORNIA.

Not sought for at first—Earliest explorations—Trans-Sierra California—An arid and sterile land.

Being so wholly absorbed in searching after and gathering gold, the inhabitants of California paid no attention whatever to silver during the first decade of the mining era. There were, to be sure, traditions among the native Californians of silver ores having been found in the country prior to its occupation by the Americans—Alisal, in Monterey County, being the site of one of these reputed silver finds. As these Alisal ores have since been shown to be both poor and scanty, it may fairly be presumed that no argentiferous deposits of any value were ever met with in California prior to its transfer to the United States, and not for about fourteen years thereafter. That our pioneer miners, with so little to encourage them, were not much inclined to hunt after silver so long as the more royal metal continued tolerably plentiful, may well be supposed.

Not, therefore, until the discovery of the Comstock lode, with its great promise of silver, was the attention of our people strongly directed to the business of seeking after and mining for that metal; and even after the occurrence of that event most of the explorations carried on, and the mining operations engaged in, were for several years at first conducted outside the limits of this State. Not before the Summer of 1861 did the Nevada prospectors for silver, working south from the Comstock lode, make their way over the line into California; the country first explored by them consisting of the territory at present embraced in Alpine and Mono Counties; the still more extensive region lying further south, and now constituting Inyo County, not having been reached until a year or two later.

The silver field covering these several counties includes all that part of California extending from the summit of the Sierra Nevada to the eastern boundary of the State, a tract comprising more than 10,000 square miles, its length being over 200 and its average breadth fully 50 miles. It is an elevated, rugged, dry, and barren region, and except along the easterly slopes of the Sierra contains very little timber, none whatever suitable for making lumber. It is skirted in part on the east by a high range, the northern extremity of which is known as the White, the central portion as the Inyo, and the southern as the Coso Mountains. This range runs nearly parallel to the Sierra Nevada, Owens Valley, a broad depression over 100 miles long, lying between them. The bottoms along Owens River, which courses through the middle of this valley, comprise about all the agricultural land to be found in the entire district, though the bunch grass, which grows sparsely everywhere, affords considerable pasturage. The general barrenness of this region arises, not so much from the poverty of the soil, as from the aridity of the climate and the limited amount of water to be had for irrigation, without which little can be raised.

GEOLOGICAL FORMATION AND CHARACTER OF ORES.

The Sierra Nevada, which walls in this region on the west, consists largely of granite, the other mountain ranges lying further to the east being composed of the same rock, associated with limestone, dolomite, diorite, porphyry, and syenite; slates occur here, also, in great abundance. The dolomites and limestones appear sometimes capping the higher ridges, while again they occur along the slopes of the mountains in extensive beds alternating with dikes of slate and eruptive rocks. Basalt, columnar in structure, in some places faces the cliffs, while in others the volcanic tufas weathered into pinnacles and spires, form the crests of the broken and castellated mountains.

Not only the higher mountains and their outlying ridges, but also the isolated foothills throughout this tier of counties, abound with mineral veins, carrying both the precious and the useful metals. In some of these veins gold, and in others, silver predominates. Some contain only argentiferous galena, while others carry silver mixed with antimony, lead, copper, arsenic, zinc, nickel, and other baser metals, the presence of which renders these ores exceedingly refractory. While many of these veins are feeble, much broken up, and contain but little ore or only ore of a very low grade, others are powerful, regular, and heavily mineralized, carrying large bunches, and even considerable bodies of high grade ores. Salt, soda, lime, and iron for reduction purposes can be obtained at little cost in most parts of this country, heavy deposits of salt, soda, and borax occurring in the southern and eastern portions of Inyo County, and also just over the line in the State of Nevada at points bordering on Mono County.

ALPINE COUNTY.

The history of silver mining in this county, where the business has now been pursued for twenty-three years, is altogether unfortunate, the product of bullion having apparently been in the inverse ratio of the labor and capital expended on the mines. No portion of trans-Sierra California is so favorably situated as regards access and facilities for cheap mining and ore reduction as Alpine County, nor has any other county been so extensively advertised as this. A good natural and nearly level wagon road connects the mining districts with Carson City, on the Virginia and Carson Railroad, fifty miles distant. This road, through its connection with the Central Pacific, has given for nearly twenty years railroad communication between Carson and San Francisco. All supplies for these mines, machinery included, could, therefore, be obtained during this time at comparatively low rates, Carson Valley and other rich farming districts in the vicinity furnishing all kinds of agricultural products at equally low rates. The mining districts of Alpine abound with wood and water, a considerable portion of them being covered with heavy forests, while a number of large streams flow centrally through them, affording much water power. The mountains in which the mineral-bearing veins occur are for the most part very steep, making it possible to open up these veins to great depths by means of comparatively short tunnels. Existing conditions being so favorable for cheap ore extraction and reduction, the ill success that has attended mining operations here cannot justly be attributed to them. The miners of Alpine and their representatives have complained that capitalists, being ignorant of or not appreciating the advantages of that section of country, have failed to invest in the mines there to the extent warranted by their obvious merits.

The Director of the Mint, in his last published report, speaking through one of his assistants, voices the above complaint in the following language:

> The mining interests of Alpine County still remain, to a great extent, neglected by capitalists, although the showing is of the very best. The mines have been discovered a number of years, and the facilities for reaching them from the centers of population are of the best; the climate cannot be excelled—a great abundance of wood and water—all these facilities for working our mines cheaply and profitably, seem rather to deter mining men from coming here, and instead, seek investments in more inaccessible and disadvantageous regions.

In so far as the foregoing is intended to convey the impression that but little capital has been invested in Alpine County, it is not strictly in accordance with the facts of history. A great deal of money (not less certainly than a million dollars), all supplied from outside sources, has been expended in that county in the furtherance of mining operations there. Mills were built for crushing, and furnaces put up for roasting the ores; shafts were sunk, and hoisting works erected over them; long and expensive tunnels were driven into the lodes, opening some of them up to great depths; roads were excavated for transporting the ores from the mines to the reduction works—the most of these improvements, all made at an early day, having been of a costly and serviceable kind. And yet, with all this financial aid, furnished so liberally and so early, not enough bullion has ever been produced in Alpine County to reimburse the money expended by these investors, even if the proceeds of the mines there had been applied to that end, which unfortunately they were not. It is doubtful, in fact, if these investors have ever received back a single dollar of the many laid out in that district. Few of them retain any interest there, the most of the properties in which they were interested having, through abandonment, been suffered to fall into the hands of others. The value of the bullion produced in this county has for some time past been at the rate of about $30,000 per year, two thirds of it silver, the annual product having at no time been much in excess of that sum.

That mining operations in Alpine have resulted so badly has been due not so much to a lack of capital as to the poverty of the mines and the intractable character of the ores, combined with other difficulties, which in the future may be overcome.

There are a great many gold and silver-bearing veins in this county, but the bulk of the ores are base, low grade, and occur in bunches, no large bodies of very rich ore having yet been developed there. With improved processes, cheapened labor, and better management, such as time may be expected to bring, mining for the precious metals will yet be carried on here largely and with fair profit. As may be inferred from the small product of bullion made, very little is now being done in this county. Although a number of mines are being worked in a small way, not more than two or three of the mills formerly put up are at present being run, and these for only a portion of the time. There are not now over two hundred men engaged at mining in the entire county, though the number amounted at one time to several thousand.

MONO,

Though essentially a gold producing county, contains a number of promising silver-bearing localities, the most noted of these being in the Patterson District, situated in the Sweetwater Mountains, an outlying easterly spur of the Sierra Nevada. This district lies twenty miles north of Bodie, the principal mining center and county seat of Mono. The veins here are numerous and carry a free milling silver ore of high grade. It occurs in chimneys, some of which are apparently of large size. One mill has been put up in the district, and for more than a year past has been making a large and profitable production of silver. It is probable that others will soon be built, and, taken altogether, the outlook for these mines may be considered very encouraging.

Stretching along the easterly slope of the Sierra Nevada, and at an elevation of about 8,000 feet, is an argentiferous belt, having a linear extent of nearly fifty miles. Along this belt several mining districts have been formed; but in none of them, except the Tioga, has much effective work been performed. In this district the Great Sierra Company has run a tunnel that intersects their ledge at a depth of nearly a thousand feet, cutting a good ore body, but beyond this very little else has been done here. In the Homer District, on this range, where a mill has been put up and a good deal of exploratory work done, the veins are mostly gold bearing. In the Montgomery District, at Hot Springs, Partzwick, and about Benton, in the southeastern part of the county, occur silver-bearing deposits, some of which have been worked at intervals, and with good average results, for many years past. These ores are generally of high grade.

INYO COUNTY.

While this, like Mono, is both a gold and silver-bearing county, the latter is here the predominating metal, some of the mines having turned out silver in large values.

This region was first visited by prospectors in 1860, who were looking for gold, and the fabulous "gun-sight lead." A somewhat detailed account of these early explorations may be found in the third annual report, folio 33, the section then explored consisting of the country lying to the east, south, and west of Owen's Lake. Several small stamp-mills were put up here during the following two or three years; but the remoteness of the district, and the hostility of the Indians so interfered with operations, that the country was for years practically abandoned.

Bishop Creek, an agricultural valley, and Owen's Valley, were settled in January, 1862. The Indian war broke out in February, and the battle of Lone Pine was fought March 22. Colonel Geo. S. Evans arrived with troops, and established Camp Independence, April 5, of the same year. From that time until 1865, there were a succession of Indian outbreaks, although prospecting was still carried on, and the county was proved to be a rich mineral region. After this date, the business of mining for the precious metals was carried on with vigor and success at several different points in the county; the most active and largely productive localities since having been the Cerro Gordo, Beveridge, Deep Springs, Darwin, Bishop's Creek, Inyo, and Panamint districts.

Taken altogether not less than twenty-five or thirty mining districts have been formed in Inyo County, many of which have, however, failed to maintain their organization. Three fourths of these are situated in the east lying chain of mountains, the remainder being located in the lower ranges between these mountains and the main Sierra and along the easterly slopes of the latter. In two thirds of these districts the prevailing metal is silver, the deposits being worked as silver mines. Some of the metalliferous veins here carry only gold, some only silver, while others carry these metals, either one or both, intermixed with lead, copper, antimony, etc. Some of these ores are free milling, though the greater portion require special metallurgical treatment.

The value of the bullion taken out in these several counties amounts, probably, to a total of twenty million dollars, nearly three fourths of it consisting of silver, and mostly the product of the Cerro Gordo mines.

THE CERRO GORDO DISTRICT,

Situated in the Inyo Mountains, 12 miles easterly from the upper end of Owen's Lake, and at an attitude of 7,000 feet above sea level. These mountains are at this point exceedingly sterile and afford but little wood or water. They are composed mainly of metamorphic slates traversed by belts of limestone and porphyry. The metalliferous veins here occur either altogether in the limestone or at the line of contact between it and the slates. The most of them dip from 60° to 70° to the southwest and have a northwesterly and southeasterly strike, running nearly with the longitudinal axis of the principal range of mountains. They consist of two classes, those which carry argentiferous galena and those which carry chiefly copper, the vein matter in the first being composed of limestone and in the latter of quartz and quartzite. Although work began here as early as 1868 not much bullion was taken out until 1872, the mines previously having been operated in a small way and for immediate results. From 1873 to about 1879 the value of the silver taken out here averaged over $1,500,000 per year, and as the ores were mined and beneficiated at a moderate expense, the profits realized on this production were large. While a number of small companies have continued work here, the larger companies and principal bullion producers have done very little for the past four or five years, the more prolific ore bodies having been exhausted. Of late the work of exploration has been partially renewed in the well founded hope that new ore bodies will be developed.

These Cerro Gordo ores consisted largely of the carbonate and the sulphates and sulphide of lead, and on an average yielded twenty per cent lead and about $60 in silver to the ton. The base bullion, which was worth about $300 per ton—lead, silver, and gold—was sent to the Selby works at San Francisco for parting and refining. The scarcity of water at these mines necessitated the laying down of pipes to a spring ten miles distant. To pass this water over interposing ridges of the Inyo range it had to be lifted to a height of 1,860 feet, which was accomplished through the agency of three Hooker steam pumps placed 3,800 feet apart, each pump overcoming a vertical lift of 620 feet. These works were completed in May, 1874, at a cost of $74,000, after which water was supplied to the inhabitants of the town at the rate of three cents per gallon, less than half of what it had before cost them.

Several years since a mining excitement carried quite a large population into the Panamint District, situated in the southern extremity of the Coso Mountains. But the movement resulted disastrously to nearly all concerned, a vast amount of labor and money having been expended in the construction of roads, building towns, and putting up reduction works not warranted by the character of the mines. This Panamint fiasco illustrates very forcibly the impolicy of making costly improvements in advance of ore developments.

Recently there has occurred some revival of mining operations at various points in Inyo County, this increased activity being due in part to more careful and economical modes of procedure, but mainly to the advent of the Carson and Colorado Railroad in that region, whereby the cost of working the mines and shipping out their products has been greatly reduced.

SAN BERNARDINO COUNTY.

During the past two or three years a very extensive and promising silver field has been opening up in the Calico and adjacent districts, San Bernardino County; and while it is yet too early to pronounce upon the permanence of the deposits there, indications denote for this region mineral resources of no mean order. Thus far these mines have produced a total of five or six million dollars, and at a comparatively small cost. They have been almost entirely self-supporting, very little capital having been invested, either in opening up or supplying plant to the mines. The ores contain for the most part chloride of silver, easily worked by crushing and amalgamation in pans, after the Washoe plan. The veins occur here of all sizes, though the majority of them are rather small. The ores which are found usually in streaks, bunches, and chimneys, are of a high grade, and, in the claims worked, have been found to hold from the surface as far down as developments have extended, between five and six hundred feet. There are now about 2,000 miners in that region, the most of them working their own claims in a small way, the richness of the ores and the facility with which they can be extracted and disposed of rendering this practicable. At first the ores were nearly all shipped in small lots, and marketed in Oakland and San Francisco; now the bulk of them is worked on the ground, the larger companies owning their own mills, of which there are five or six in the county, while the miners sell most of their ores to the custom mills, which sample and buy them. These sensible and business like methods having been adopted and adhered to from the first, mining has been kept in a healthful and progressive condition, these districts presenting the most satisfactory record of any in the history of silver mining on this coast. No other silver-bearing field has received so little outside aid, nor has any other made such a steady and profitable production from the start.

The Calico, the central and principal mining district in this region, is distant about four hundred and eighty miles southeast from San Francisco, and ninety northeast from the town of San Bernardino, the county seat. It is reached by the Southern Pacific Railroad to Mohave Station, and thence over the Atlantic and Pacific Railroad, which traverses the district centrally in an easterly and westerly direction. The Calico mines yield only silver, but some of those in the outlying districts, of which there are several, produce both silver and gold, the ores here carrying also, in some cases, lead, copper, and other base metals, which render them stubborn of reduction. These districts are all included within the limits of the Mohave Desert, a sterile, timberless, waterless region, arid at all seasons, and very hot in the Summer, the great plain that constitutes this desert being but little elevated above ocean level. As the mines are somewhat more elevated, being situated for the most part in the mountains, the Summers here are scarcely so hot as in the plains below. For eight months in the year the climate is pleasant and extremely favorable for the prosecution of outdoor labor, which is little interrupted by cold or stormy weather, there being hardly more than a dozen rainy days in the course of the year. There is little or no snow in the mines, though it falls to a considerable depth on the higher mountains in the neighborhood.

Argentiferous deposits exist at many other points in California besides those above mentioned. Some of these have been worked, several in Shasta County, but never with very encouraging results, the ores being for the most part base and difficult of treatment. As many of these deposits are, however, rich in silver, with wood and water convenient, they will, doubtless, come in good time to be worked to an extent commensurate with their merits. There are on the island of Santa Catalina heavy veins of white quartz carrying much argentiferous galena. An attempt was made many years ago to utilize this ore, but it was found to run so low in silver that the effort was abandoned as unprofitable.

PAST PRODUCTION AND FUTURE PROSPECTS.

The production of silver made in California to date has been, as per table given below, the yield prior to 1871 and for the year 1884 being estimated:

Prior to 1871	$1,000,000	1878	$1,700,000
1871	250,000	1879	2,350,000
1872	750,000	1880	1,250,000
1873	1,000,000	1881	1,000,000
1874	1,700,000	1882	1,500,000
1875	2,000,000	1883	2,500,000
1876	2,500,000	1884	3,500,000
1877	3,000,000		
			$26,000,000

This value represented by pure silver would, if cast, form a cube $12\frac{3}{10}$ feet high, nearly.

That silver mining, as heretofore conducted in California, has proved generally unfortunate, is not to be denied; but in accounting for such lack of success there is this to be said: Our people were at the outset but little acquainted with this business—knew hardly anything about the character of silver-bearing ores, their modes of occurrence, or the proper manner of treating them; and if we had here a few skilled mineralogists and metallurgists to whom we could apply for aid and guidance, the most of these were men who had received their schooling and practiced their callings under circumstances very different from those by which they found themselves here surrounded—so different, in fact, that under these new and strange conditions, denied the conveniences and facilities for operating to which they had been accustomed, these adepts proved almost as much at fault as those who were strangers to the business; the failures for a time, at first, having been in about equal proportions between the novices and the trained experts. Then, as has already been stated, the country where our first attempts at silver mining were carried on was exceedingly barren, isolated, and far removed from points of supply, long chains of rugged mountains intervening between them. This, in the absence of railroads, retarded ore development, while it rendered improvements and operations of all kinds very expensive. Laboring under these difficulties and drawbacks, no very rapid progress could be expected; nor if some mistakes, a few of them not altogether excusable, were sometimes committed, is this to be wondered at? Reviewing the past, and surveying the whole field as it opens before us, we think there is abundant reason to believe that the business of silver mining, promoted by more legitimate means, and aided by better methods, is destined to take its place among the most largely productive, profitable, and enduring industries of California.

Silver Glance—see Argentite.

Slate—see Building Stones.

136. SMITHSONITE. Carbonate of Zinc.

Said to occur with cerusite in the Modoc mine, Inyo County.

137. SODA NITER.

This important mineral is nitrate of soda (NaO, NO_5).

Nitric acid	63.5
Soda	36.5
	100.0

H=1.5—2. Sp. gr.=2.09—2.29. It is soluble in water and has a cooling taste. It deflagrates when heated in a platinum spoon with charcoal. B. B. melts and colors the flame yellow (soda). The desert lands of Southern California, Arizona, and Nevada, resembling those of Peru, Chili, and Ecuador, it has been thought that nitrate of soda would be eventually found here. This prediction has been verified, it having recently been discovered in at least two localities in California and one in Nevada. The site of the most important California discovery, which occurred in April, 1883, is near the town of Calico, San Bernardino County, small quantities of the mineral having been observed at several places in that vicinity. Samples gathered there and sent to the State Mining Bureau for examination, were found to be quite rich in nitrate of soda. But what these deposits are likely to amount to we are not advised, though presumably measures have been taken to determine their probable extent and value, as the district whence these samples came is marked by conditions favorable for the occurrence of this salt.

The Nevada find, the discovery of which dates some two years earlier, is located on the Humboldt desert, at a point eight miles from Lovelock Station, on the Central Pacific Railroad. The nitrate occurs here imbedded in the earth from two or three inches to as many feet beneath the surface. It is found, also, in thin seams in the rocks of the mountains adjacent. While these rocky deposits are of no practical value, they denote the probable sources from which the beds out on the desert were originally derived. The contents of these crevices, where exposed to the rains, are dissolved and carried away, the hot dry weather reproducing them each succeeding Summer. Though scattered over a considerable area, the salt has not, as yet, even in the main deposit, been found sufficiently concentrated to admit of any large quantity of fair grade being collected here. The company who own this ground express a purpose of prospecting it thoroughly, in the hope of finding more valuable deposits of the mineral than have yet been met with.

The geological features, mineral products, and climatic conditions of these northern localities bear a strong resemblance to those of the nitrate-bearing territory of South America. Here, as in the district of Tarapaca, on the coast of Peru, but little rain ever falls. There occur here, also, as there, the borates of lime and soda, also immense beds of common salt and carbonate of soda, with marine shells, denoting that the country was once covered by the ocean, or that it was the bed of an inland sea. Lying to the east of Tarapaca is another extensive nitrate field, but it has been but little utilized, being eighteen miles from the coast, with a barren and sandy stretch of country intervening. Both of these beds are, in fact, located on the great Desert of Atacama, a sterile, treeless, and nearly rainless region, similar to the districts in which the California and Nevada deposits occur. The South American nitrate is usually found covered first by a layer of earth from five to twenty inches in thickness, underlaid by a compact stratum of gypsum, below which the salt occurs in irregular strata and bunches from two to ten feet in thickness, a good deal of it being intermixed with gypsum, salt, and other impurities. The nitrate-bearing lands extend here over an area of forty square leagues. Other finds of this salt have, from time to time, been announced as having occurred in California or elsewhere on the Pacific Coast, but which, on more close examination, have proved illusory, the mineral mistaken for saltpeter turning out to be some worthless substance.

There is said to be a group of springs in the extreme southern part of New Mexico, which deposit the nitrate of soda in limited quantities. No use has as yet been made of this material, except that some of it has been packed away by Mexicans, a portion of these springs being over the line in the State of Chihuahua. That these deposits will become of much commercial importance is not at all probable.

HOW PREPARED.

As nitrate of soda does not occur pure in nature, it has to be refined to fit it for the use of the manufacturer. To this end, the crude material, after being broken into small pieces, is dissolved in boiling water, the earthy and other insoluble matters falling to the bottom. The clear liquor being then drawn off, is run into shallow troughs, where, exposed to the dry and cloudless atmosphere, it soon evaporates, and crystallizes into the nearly pure article of commerce. There are many of these rude refineries scattered over the district of Tarapaca. Iquique is the port whence the refined product from this district is shipped to foreign markets.

USES AND CONSUMPTION IN CALIFORNIA.

The purposes for which this salt is mainly employed, are as a constituent in the manufacture of gunpowder and for making nitric acid.

Owing to its deliquescing tendency, it is unfit for the former use until first properly prepared. Our imports of this commodity amount to about 5,000 tons annually, divided up among the acid and the powder works. The Judson & Shepard works take more of this salt than all the other works in the city, this firm turning out 1,500,000 pounds of nitric acid per year. The nitrate of soda averages in this market about two and one quarter cents per pound by the cargo, our supplies all coming from Peru. Shipments from this point east, over the Central Pacific Railroad, amount yearly to between sixty and seventy thousand pounds.

This Peruvian nitrate constitutes, also, a very valuable fertilizer. Although applied as yet for the enrichment of the soil in only a limited way, its consumption for this use must ultimately become very large. Fortunately for oncoming generations, there is in these South American fields enough of this material, mixed with other fructifying agents, to last, under the heaviest drains likely to be made upon them, for a very long time. The Province of Tarapaca is alone estimated to contain not less than 63,000,000 tons of nitrate.

The value of the nitrate of soda imported annually into the United States has, during the last decade, ranged from $1,000,000 to nearly $4,000,000, the imports of 1882—180,000,000 pounds, the largest of any one year—having been valued at $3,911,545. The imports of this commodity into Great Britain average over 100,000,000 pounds per year.

The method of testing for the nitrates is very simple, although the determination of the quantity contained in a given sample is somewhat difficult. For the prospector, the following test will serve to show whether nitrates are contained in a suspected sample of crude material or not: Nitrates are most likely to be found in dry alkaline sands, alkaline incrustations, and in the floors of caves. The test is made by placing some of the loose earth in a common miner's pan, adding water and stirring from time to time for some hours. If heat can be applied, the solution will be complete in a shorter time. The contents of the pan are then allowed to settle and the nearly clear solution poured off into some convenient vessel. The pan is then washed and the liquor returned to it. This is either allowed to stand in the sun until evaporated to dryness, or more quickly evaporated over a fire. When dry the residue is mixed intimately with an equal volume of charcoal, and thrown on red hot coals, or on a plate of red hot iron; if the substance contains any nitrate the powder will deflagrate like wet gunpowder. This test is very characteristic.

Specular Iron—see Hematite.

138. SPHALERITE. Blende, Zinc Blende, Black Jack, Sulphuret of Zinc.

The name "sphalerite" is from the Greek, meaning treacherous. The original name "blende" is from the German, meaning blind, deceiving, because blende while resembling galena produced no lead. Composition (Zn. S.).

Zinc	67
Sulphur	33
	100

H=3.5—4. Sp. gr.=3.9—4. Color, black, brown, yellow, green; streak, white. Transparent, opaque. In open tube gives sulphurous fumes. B. B. on ch. is not easily melted or decomposed by heat, but if pulverized in an agate mortar and mixed with carbonate of soda, then on ch. it is decomposed and the zinc burns with a greenish flame, and an incrustation of oxide of zinc is formed on the charcoal, which is yellow, while hot, but becomes white when cold. If this incrustation is touched with a glass rod dipped in a solution of nitrate of cobalt, and again heated, it assumes a beautiful and characteristic dark green color. If lead is present in the mineral, which is commonly the case in California, there will be a yellow incrustation also, but the latter test is conclusive. The cobalt solution in this case may be applied directly to the assay.

Zinc blende is very abundant in California, disseminated through the vein matter in gold and silver mines, but has not been found in distinct veins. When concentration is adopted in treating low grade ores, zinc will become worthy of attention, and will be saved and utilized. It occurs at Meadow Lake, Nevada County, in considerable masses, with galena, pyrite, and chalcopyrite; and associated with yellow copper in the Lançha Plana and Napoleon copper mines in Calaveras County (Blake).

It is represented in the State Museum by the following specimens: Nos. 1633, 1632, 1891, in calcite, White Chief mine, Mineral King District, Tulare County; (2154) Dennis Martin's ranch, four miles west of Menlo Park, San Mateo County; (4070) with calcite, Small Hill mine, Santa Catalina Island.

SPHENE—see Titanite.

STALACTITE—see Calcite.

STALAGMITE—see Calcite.

STEATITE—see Talc.

139. STEPHANITE. Etym. *Stephan*, Mining Director of Austria. Brittle Silver Ore, Brittle Sulphuret of Silver.

This is a double sulphide of silver and antimony. ($5\ Ag.S+Sb_2S_3$.)

Sulphur	16.2
Silver	68.5
Antimony	15.3
	100.0

Found in the Morning Star mine, Alpine County (Dana).

140. STIBICONITE. Partzite, Antimony Ochre, Hydrous Oxide of Antimony.

Partzite is found in abundance in Mono County. It seems to be a mechanical mixture of stibiconite with other oxides, and is always rich in copper and silver. It was first analyzed by A. Arents, and the analysis published in the *American Journal of Science*, series 11, volume xliii, page 362, as follows:

Teroxide of antimony	47.65
Oxide of copper	32.11
Oxide of silver	6.12
Oxide of lead	2.01
Oxide of iron	2.33
Water	8.29
	98.51

Color yellow, pea-green to black, generally coated with chrysocolla. H.=3—4. Sp. gr.=3.8. B. B. in forceps, nearly infusible, melting only on the thinnest edges. In closed tube gives much water. B. B. on ch. alone, after some time a coating of antimony oxide is formed. With carbonate of soda, metallic, white, brittle beads are obtained in a yellowish-green slag. The beads on being treated with nitric acid are decomposed, leaving a white residue of antimony; with an addition of hydrochloric acid perfect solution takes place which is golden yellow. On adding ammonia the solution becomes blue (copper), and a slight precipitate of iron and alumina falls. In several specimens I examined, no silver reaction was obtained, although specks of free silver could be seen in the ore. I am inclined to think that the silver is always in a free state, and that the mineral is heterogeneous, and not uniform in its composition. I question if two analyses could be obtained exactly alike. Partzite, named after Dr. Partz, employed in the metallurgy of ores at Benton, Mono County, where the mineral was first discovered, occurs in the same veins with silver chloride, lead and copper carbonates, galena, and iron oxide. The latter contains a compound of manganese not determined, but probably protoxide or carbonate, which, when treated with a hot solution of copper chloride, replaces the copper in the solution (Aaron).

Magnificent specimens with free silver are found in the Diana, Kerrick, and Comanche mines, Blind Springs District, Mono County. It is represented in the State Museum by No. 256, from the Kerrick mine, Benton, Mono County; (2919) from the Comanche mine, Blind Springs, Mono County; (4759), with native silver and galena, from the Tower mine, near Benton, Mono County.

141. STIBNITE. Etym. *Stibium* (antimony). Sulphide of Antimony, Antimony Glance. (Sb_2 S_3.)

Antimony	71.8
Sulphur	28.2
	100.0

H=2, sp. gr.=4.5—4.6; luster highly metallic; color and streak lead-gray, sometimes tarnished black or iridescent. In open tube sulphurous and antimonial fumes are given off, the former recognized by the smell, the latter coating the inside of the tube white; very fusible. On ch. B. B. melts and coats the coal white, giving off at the same time dense white fumes of oxide of antimony. With a small portion of cyanide of potassium and carbonate of soda, at a gentle heat, a bead of metallic antimony is reduced. Soluble in hydrochloric acid and in hot solution of caustic potash, from which nitric acid precipitates orange sulphide of antimony. On adding more acid, the sulphide is decomposed to oxide of antimony and sulphur, which remain insoluble.

Antimony is a brilliant white brittle metal, fusible at a low heat

(797°). When broken it shows an internal lamellar structure, sp. gr.=6.7 to 6.8. Does not oxidize in the air; may be distilled or sublimated at a white heat. In the open air it oxidizes at a red heat and yields dense white fumes of oxide of antimony. It is not attacked by the dilute acids, except nitric and nitrio hydrochloric. By the former it is oxidized but not dissolved, but is wholly so by the latter with heat. It is not certain when antimony was discovered, but it was known to the alchemists and was used in medicine near the end of the fifteenth century. It is seldom found in a metallic state in nature, but occurs combined in numerous minerals and with sulphur in stibnite. Crude antimony, black antimony, the antimonium of the pharmacists, is stibnite purified and concentrated by fusion at a low heat in air tight crucibles or vessels of iron, with an aperture near the bottom, through which the fused sulphide flows, leaving the silica and other impurities behind. From this crude antimony the metal and preparations of the metal are obtained. Besides its use in medicine it is employed in alloys to give hardness to other metals deficient in that property, notably in type metal and anti-friction alloys.

Antimony may be distinguished from all other metals by its brittleness, white color; forming a white powder when boiled in nitric acid. The white coating which it leaves on charcoal when heated; white sublimate in closed tube, and the yellow precipitate produced by sulphide of ammonia in acid solution, which is soluble in excess of the reagent.

METALLURGICAL WORKS.

On the strength of what was considered reliable information, to the effect that there existed an abundance of antimonial ores within easy reach of San Francisco, two establishments were put up for treating this class of ore—the one in Oakland and the other in this city. The former, which was costly and of large capacity, after having been run for a period on an oxide ore, obtained from Sonora, Mexico, was closed down, and so remained until a short time since, when it was accidentally destroyed by fire. The enterprise involved a serious loss, most of it falling on Boston parties.

There was in this case no lack of a tolerably good ore supplied at a moderate cost, yet the venture seems to have afforded no room for profit. The works put up in this city by Messrs. Starr & Mathison, though of limited capacity, have remained a part of the time idle by reason of their inability to obtain enough ore of sufficiently high grade to keep their furnace constantly running. As the cost of reducing this mineral in San Francisco is large, a suitable fuel being expensive, and as they have been obliged to find a market for most of their product in New York, this firm has not sought to handle ore carrying less than fifty per cent metal.

CONSUMPTION, PRODUCT, AND PRICE, IN THE UNITED STATES.

While the consumption of metallic antimony in the United States amounts to some twelve hundred tons per year, the entire country produces hardly more than sixty tons, worth an average of about ten cents a pound. This metal, in its pure state, is too brittle to be used for any purpose except as a mixture with certain other metals to which, as an alloy, it gives hardness. Twenty per cent, added to lead, renders the latter hard enough for printers' type, the largest single use to which antimony is applied. In the mechanic arts it is employed to impart anti-friction properties to Babbitt metal, used for bearings in machinery. It is also used for pharmaceutical purposes.

The consumption of antimony on the Pacific Coast is small, amounting to not more than thirty tons per annum.

To obtain enough ore of the requisite grade to keep their works going for as much as three fourths of the time, Messrs. Starr & Mathison have found to be a difficult matter, notwithstanding high prices are paid for this class of ore.

The California export of this metal, all from San Francisco and Oakland, amounted in 1882 to a little over thirty tons, the value of the ore shipped to England having been $5,850. Both the ore shipments and the quantity of metal made were less in 1883 than during the preceding year.

CALIFORNIA LOCALITIES.

Stibnite has been found in several localities in the State. It is generally, if not invariably, associated with mercury in California, and the same is the case in Borneo, where antimony is largely produced. Stibnite has been found in considerable quantity in Kern County. The antimony mines in San Emidio Cañon, Township 10 north, Range 21 west, Kern County (No. 4092), were discovered in early times. It was supposed by the Indians to be silver ore. It was visited by W. P. Blake in 1854. His description appears in volume 5 of the Pacific Railroad Reports, folio 291. Professor Whitney mentions the locality in Geology of California, folio 189, but places it in Arroyo Plata, west of San Emidio. The ore occurs in large solid masses, bowlders of which are numerous in the beds of the arroyos leading from the vein (Blake).

Mr. S. Boushey, Alex. B. and Geo. Chaffey, and G. H. Howland, have recently commenced work on this mine, and are reducing the ore to matte or crude antimony by economical methods. They use ten iron pots, in each of which one hundred pounds of crude ore are heated in an oven-shaped furnace. The operation requires one hour only. The crude antimony flows through holes at the bottom of the pots. I saw fine specimens of crude antimony from this mine in the rooms of the Board of Trade in Los Angeles. The Alta antimony mine is situated in the McLeod mining district, San Benito County, fourteen miles northeast from Hollister, on Section 30, Township 11 south, and Range 7 east. The company was incorporated April 20, 1875. The present owners are N. P. Sheldon, S. W. Collins, R. H. Orton, and Samuel Ambrose, the last named gentleman acting as Superintendent. Over $2,000 has been expended on the mine. There is a tunnel driven on the vein 207 feet, and a shaft sunk 100 feet. Twenty feet of the shaft is in ore (stibnite, 4099) which occurs in splendid crystals. The vein is solid ore from three inches to two and one half feet in thickness. No stoping has been done. The company has no reduction works. Analysis in Germany showed the mineral to contain no arsenic, lead, or other objectionable matters. The company have no matured plans as to mode of working the ores, but are determined to more fully develop the mine before expending capital on reduction works. At the Stayton mine in the same county the ore is said to exist in large quantities, but that it is not of very high grade may be inferred from the fact that the former owners of this deposit, after expending considerable sums in putting up reduction works, building roads, and otherwise improving the property, were obliged to suspend operations, having found no profits either in treating the ore on the ground or sending it to San Francisco for a market. Besides the rather poor quality of the ore, there existed other obstacles to success, such as costly transportation, the mine being situated in a rugged cañon at a considerable elevation in the Coast Range, and a long way from the railroad, scarcity of timber suitable for making good lumber, etc. The reported discovery of a body of rich ore in the vicinity of this mine, though probably well founded, needs confirmation.

Stibnite is found elsewhere in the State. In washed bowlders, Centennial mine, San Bernardino County; Pacheco Pass, Monterey County; (1631) Mammoth mine, Mineral King District, Tulare County; in the Panamint Mountains, Inyo County, in large veins; at the head of Bloody Cañon, Mono County (4349) with chalcedony, and cinnabar, Lake quicksilver mine, Lake County; (4354) near Kernville, Kern County, and in Santa Barbara County (Dana).

OTHER LOCALITIES WEST OF THE ROCKY MOUNTAINS.

A deposit of antimony ore found at a point twelve miles south of Battle Mountain, in Humboldt County, Nevada, after having been worked irregularly, but with some success, for a number of years, appears to have been so far exhausted that operations upon it have been suspended with little likelihood of their being resumed. Deposits of this ore are said to exist at other points in that State, but nothing determinate is known as to their extent or value. In the Wood River region, Idaho, antimony is found associated with argentiferous lead ores, the same being the case in some of the adjacent Territories.

On the headwaters of the Sevier, in southern Utah, a number of antimony-bearing veins were, not long since, discovered. Some of these veins have been opened up with results that denote for the find a good deal of importance. From one or two of them ore of an excellent quality is being extracted and reduced at the works put up at the mines. Considerable metal is being turned out here daily, and the enterprise promises a favorable issue. What most imperils its success is the long wagon transportation required for getting in supplies and shipping the metal to market, the locality being 60 miles from Milford, nearest station and present terminus of the Utah Central Railroad. Another drawback is found in the generally barren character of the surrounding country, which is also but poorly supplied with timber and water.

142. STROMEYRITE. Etym. *Stromeyer*, chemist who first analyzed it. Silver Copper Glance.

Gives the reactions of chalcosite (which see), except that it contains silver. The proportions are so variable that I have thought it was a mechanical mixture of the two minerals. It occurs with other silver and copper ores in the White Mountains, Inyo County (Aaron), and is not uncommon in the Inyo Mountains, from the White Mountains to Coso.

SULPHATE OF COPPER—see Chalcanthite.

SULPHATE OF IRON—see Coquimbite.

SULPHATE OF SODA—see Thenardite.

143. SULPHUR.

ETYMOLOGY AND MODE OF OCCURRENCE.

The term sulphur is derived from the Latin word *sal* (salt), and the Greek for fire. It is an elementary substance and seems to be a general mineralizer, being found in nearly all mineral veins in some form or another. It occurs in nature generally as a surface, though sometimes as a deep-lying deposit, and usually with gypsum and celestine, resulting from the decomposition of other minerals. It is also found in volcanic craters and solfataric vents, in mineral waters combined with hydrogen, in nature as sulphuric acid, and combined with metallic bases, as sulphides, and in certain organic compounds; is obtained artificially in the purification of coal gas. Sulphur is thought to result from decomposition of two gases, hydro-sulphuric and sulphurous, thus, $2HS+(SO_2=3S+2HO)$; or by the oxidation of hydro-sulphuric acid, thus, $(HS+O=HO+S)$. The oxygen may be derived from the decomposition of water or some secondary reaction. Both these gases are abundant at the mud volcanoes in San Diego County and in mineral waters.

PRINCIPAL USES.

The uses for which sulphur is principally employed consist of the following: The manufacture of gunpowder, sulphuric acid, matches, fireworks, mosaic gold, and for taking impressions of coins, medals, etc. It is also employed in the arts for producing vermilion and ultramarine colors, and for vulcanizing India rubber; in medicine, for purifying the blood, the treatment of cutaneous diseases, and as a disinfectant; in metallurgy, for precipitating silver; in agriculture, for the destruction of insects on plants, vines, etc., no less than 89,600,000 pounds having been consumed during the year 1883 in France, Italy, and Spain for killing the phylloxera in the vineyards of those countries, much being also used elsewhere for this and similar purposes. More of this mineral is employed in the manufacture of sulphuric acid than for all other purposes combined.

ITS CHEMISTRY.

Sulphur when cast in molds is called brimstone, or roll sulphur, brimstone being a corruption of the German term *brennstein*, a stone that burns. When obtained by sublimation, this mineral is known as flowers of sulphur. Its symbol is S; atomic weight or combining equivalent, 16 by the old and 32 by the new system. Sulphur is a moderately hard, inflammable, brittle, opaque substance, insoluble in water; color and streak yellow; sp. gr.=2.07; H.=1.5—2.5; melts at 218 to 227 degrees Fahrenheit; takes fire and burns at 518°. Transparent, translucent; fracture conchoidal; if cooled slowly crystallizes in needles; breaks with a crackling sound that may be heard if a piece be held in the warm hand near the ear; is a non-conductor of heat. Men employed in the sulphur works frequently pour the melted mineral over their fingers, where it congeals without burning them. Applying a number of coatings in this manner, a glove of sulphur is formed which can be removed without breaking. A curiosity of this kind, formed at the Sulphur Bank mine, Lake County, was exhibited in the California collection at the Paris Exposition of 1878. A roll of sulphur, when rubbed, acquires an odor, becomes electric, and attracts small light bodies, the electricity being negative or resinous. When heated in contact with the air, is oxidized to sulphurous acid (SO_2). Melted and thrown into water it becomes soft and plastic, in which state it is used for taking impressions of coins and the like. It crystallizes from solutions—notably from bisulphide of carbon—and forms prisms. If sulphur is melted in a large vessel and allowed to cool slowly, a crust forms on the outside, this being broken, and the contained liquor poured out, the inner surface of the crust will be found covered with crystals, like the inside of a geode. Sulphur is dimorphous; that is, it will crystallize in two forms or systems under different conditions. When crystallized from fusion, the crystals belong to the fifth system of crystallization; and when from solution, to the third. Natural crystals sometimes form three inches in diameter.

The presence of sulphur may be detected in any substance containing it by heating a small portion of such substance in an open vessel, nearly to redness, when the characteristic odor of the mineral will be observed. If the quantity is small it may be placed in a closed glass tube and heated over an alcohol or gas flame, when the sulphur will sublime and form a ring above the assay. Sulphur in any form can be detected by placing the substance with pure carbonate of soda on charcoal and fusing with the blowpipe. Place the button obtained on a silver coin and wet with water. If sulphur is present a sulphide is formed which, in solution, attacks the silver and turns it black.

Sulphur is soluble in but few fluids. The following table of the principal solvents is compiled from the Dictionary of Chemical Solubilities (Storer):

One hundred parts dissolve of flowers of sulphur parts:

Bisulphide of carbon, hot	73.46
Bisulphide of carbon, 16° C.	38.70
Rectified coal tar naphtha @ 100° C.	26.98
Benzine, boiling	17.04
Oil of turpentine, 150° C.	16.16
Mineral naphtha, boiling	10.56
Absolute alcohol	.42

The sulphur of commerce is frequently adulterated; mostly with burnt gypsum, flour, earthy substances, arsenic, etc. The presence of these foreign matters can be detected by sublimation.

ITS METALLURGY.

Sulphur is separated from earthy impurities by the following processes: By liquation, by roasting in heaps, by superheated steam, or by solution in bisulphide of carbon. The reader, for a more detailed description of these several processes than is here given, is referred to Lippincott's Encyclopædia of Chemistry, Wagner's Chemical Technology, Ure's Dictionary, and various works on Chemistry and Metallurgy.

By the liquation method, generally practiced in Sicily, the sulphur-bearing material is thrown into circular inclosures of masonry, called "calcaroni," a few faggots having first been placed beneath it to start a fire. After these faggots have been ignited, earth is thrown on the burning pile, which partially prevents the sublimation and oxidation of the sulphur, the draft being so regulated as to maintain a proper degree of heat. A portion of the sulphur is burned, and a portion fusing flows out through an opening prepared for the purpose. From forty to fifty per cent of the mineral is lost by this process, which is best suited for low grade ores. These "calcaroni" are handsomely figured in Science for All, volume 5, folio 197. Where the plan of roasting in heaps is adopted, ores containing the sulphides of iron and copper are disposed of in layers with a certain proportion of wood until a large pyramidal heap is formed, which is then covered with earth, open spaces being left into which the sublimed sulphur may collect. This pile being fired, the roasting is continued for several months, the heat resulting from the decomposition of the ores and the combustion of a portion of the sulphur being sufficient, with the small amount of wood supplied, to keep alive and spread the fire throughout the entire mass. The sublimed sulphur collects in the openings mentioned, from which it is removed several times a day. This process is fully described in Nicholson's Dictionary of Chemistry, published in London, 1795. It was first practiced in the Hartz, in 1570, being the discovery or invention of Christopher Sander.

The plan of manufacturing sulphur by the use of superheated steam has been successfully employed in California and Nevada, and is mentioned in the description given in another part of this article of the works at the Rabbit Hole mines, in the latter State.

Sulphur is also obtained by the distillation of pyrites. By this method the mineral, having been first coarsely powdered, is placed in iron retorts, to which fire being applied, the sulphur separates and melts. It is then drawn off and run into cold water; as no air is admitted the sulphur does not oxidize. In Saxony, where this process is much in use, about ninety pounds of sulphur are produced from one hundred and fifty pounds of the pyrites.

REFINING THE MINERAL.

However sulphur is obtained by first operations, it requires to be refined before it can be employed for any but the most common uses. The refining is effected either by melting in pans, by liquation in iron cylinders, or by distillation from iron retorts or earthen pots. When melted in pans the liquid is poured into wooden molds, forming brimstone or roll sulphur; when powdered, is frequently sold as sublimed sulphur, or flowers of sulphur. In Sicily, the very rich ores are melted in pots set over a fire, the impurities which come to the surface being removed by perforated ladles. When the pot is full the liquid is drawn off and cast into rolls. By liquation the ore is melted in iron cylinders; one portion of the impurities coming to the surface is skimmed off, while another settling to the bottom is left there undisturbed, the liquid between being drawn off in a comparatively pure state. This plan, once common in Sicily, has there been discontinued, having been found both troublesome and wasteful. The other process mentioned is conducted by means of an iron still set in masonry, and connected by a pipe with a brick chamber set some distance away. The sulphur being distilled passes through this pipe into the chamber, which is kept cool, and there sublimes and falls in a powder.

In Anglesea, a form of sublimed sulphur is obtained from pyrites much after the manner above described. Sublimed sulphur is very nearly pure, though the commodity sold as such is sometimes much adulterated. Where this is the case the fraud can be readily detected with the microscope, the genuine consisting of pear-shaped drops easily recognized. Much pulverized sulphur has been sold in San Francisco for the sublimed article.

In October, 1882, experimental works for the manufacture of "flowers of sulphur" by sublimation, were put in operation on Berry Street, San Francisco. The apparatus consisted of a turtle-shaped cast-iron retort set in a furnace, a cast-iron kettle which was placed above the retort, and heated by the waste heat from the retort furnace, and a condensing chamber of brickwork. The sulphur was melted in the kettle, and at intervals run down into the retort through a connecting pipe fitted with a valve which was opened and closed by means of a screw and hand wheel. The raw material was a very inferior article of Japanese sulphur, containing about 20 per cent of impurities. The apparatus was very imperfect, and much trouble and annoyance arose from this cause, but notwithstanding its many defects, some 30 to 40 barrels of a very superior article of sublimed sulphur were produced weekly for a considerable time. Causes extraneous to the business led to its ultimate abandonment, but sufficient was done to prove that it was both practicable and profitable.

SULPHUR PRODUCING LOCALITIES.

Sulphur indications and sulphur springs may be said to be of common occurrence in most of the Pacific States and Territories. But, while such is the case, and while the crude material is known to abound at a few localities, it would be misleading to even repeat the accounts that have come to hand of some of these deposits, so extravagant have they been, both as regards the quantity and the purity of the mineral represented to have been found. In California, this mineral is supposed to occur at the following localities in considerable quantity, though not always under conditions that impart to the deposits any present commercial value: near Clear Lake, in Lake County, and on an elevation known as Chalk Mountain, two miles east of Clear Lake. In the foothills of the Coast Range, thirty miles west from the town of Colusa; in Inyo County, and in the Azuzar Mountains, on the northern border of Santa Barbara and Ventura Counties; also in more limited quantities in Tehama, Napa, Kern, San Luis Obispo, Los Angeles, San Bernardino, and San Diego Counties, the deposits in the last named county, in the vicinity of the Mud Volcanoes, being mentioned in the second report of the State Mineralogist. Commencing in San Luis Obispo County, a sulphur-bearing belt appears at intervals of two to six miles, running through Santa Barbara and Ventura Counties into Los Angeles. Though never worked, nor much explored, these deposits, should they prove rich, will no doubt be utilized hereafter, as they extend through a tolerably well wooded and watered region, and lie convenient to the seacoast.

THE CLEAR LAKE EXPERIMENT.

Only a single enterprise of several undertaken has resulted in the production of any considerable quantity of sulphur in this State, that having been carried on by the California Borax Company, who, singularly enough, starting in to make that salt had their energies diverted to the manufacture of sulphur, and finally ended their career as producers of quicksilver, a business that has since proved more remunerative than either of the others. This company, discovering that the tract of land taken up on the border of Clear Lake for its borate beds contained also large deposits of sulphur, put up, in 1866, works for refining that mineral. These works, which were very complete, having been supplied with iron retorts for steam liquation, receivers, etc., were connected with the sulphur-bearing deposits by a railway 1,300 feet long. They had capacity to make from four to six tons daily, accordingly as the crude material varied in quality. The mineral here is found on an extensively fissured much decomposed solfataric rock, upon which it is deposited by the steam and hot gases that issue from the fissures. It occurs over an area of ten or twelve acres, a little of it being quite pure, though the greater portion is much contaminated with tufaceous debris, the whole averaging not more than eight or ten per cent sulphur. These works, after having been operated with a varying product for six or seven years, were finally closed down, owing to the rate at which the price of sulphur had in the interim declined, the fall having been from $75 to $40 per ton. At no time during this period was the company able to make and deliver in San Francisco a ton of sulphur for less than $35. The chief obstacles to success in this instance consisted in the impossibility of obtaining any large amount of high grade material, and the cost of getting the refined article to market, the latter necessitating wagon transportation for a considerable distance over a rough country.

The production of sulphur made by this company was as follows:

1865	214,650 pounds
1866	675,963 pounds
1867	487,603 pounds
1868	503,481 pounds
Total	1,881,697 pounds

In the manufacture of sulphur at Clear Lake, much of the product was found to be stained a dark color, the cause of which for some time remained a mystery. It appearing at length that this discoloration was due to the presence of mercury in the deposits worked, these were afterwards manipulated for that metal, the property being converted into a quicksilver mine.

THE OTHER CALIFORNIA SULPHUR FINDS

Have, in the light of developments or production made, amounted to but very little. While the foothill beds of Colusa County cover a considerable range, the most of the mineral, some of which occurs on or near the surface, is of low grade, being largely mixed with earthy impurities. A refinery was put up on the spot nearly twenty years ago, but the venture terminated after a short and profitless career; nor has anything been attempted there since. As remarked, the deposits in the Azuzar Mountains remain nearly as nature formed them, which is also the case with the others named.

SULPHUR MINES AND WORKS OF NEVADA.

While so little sulphur has been made in California, a considerable quantity has been produced by the Nevada Company at their mines and works at the locality known as Rabbit Hole Springs, in the State of Nevada. In 1873 a deposit of this mineral was discovered at the above point, which is situated about thirty miles in a northwesterly direction from Humboldt Station, on the Central Pacific Railroad. The sulphur occurs here in lime and magnesian rocks, and in irregular masses, overlaid by a stratum of dry ashy-like earth, which, being removed, the mineral can be broken out in lumps, frequently of large size, and some of it quite pure. In 1876 a single piece of sulphur was taken out here that weighed 1,200 pounds. It was started for the Centennial Exposition, held that year in Philadelphia, but having got broken on the way, never reached its point of destination. These Rabbit Hole deposits are no doubt extensive, being spread over a large area, in bodies of mineral more than one hundred feet in length, and showing an average thickness of twenty by a depth of thirty feet, having been uncovered there.

For working these deposits two companies were formed and proceeded to put up refineries on the ground soon after their discovery. One of these companies proved short lived and the other, though still in existence, has achieved but a moderate success, the cost of getting their product to a market having, as with their predecessors in the field, been the chief obstacle in the way. The expenses of operating at this point have also been great, the country around being dry, barren, and timberless, necessitating the importation of supplies of all kinds. The production made at Rabbit Hole has varied, having amounted some years to a thousand tons or more, while again it has fallen to less than half that amount, the quantity made for the past year or two having been small. This product, the most of it refined sulphur, though some selected lots consisted of native mineral, has nearly all been marketed in San Francisco, having been consumed by the acid works here. A little was also taken by the manufacturers of bluestone at Dayton, Nevada.

The expenditures made by these two companies in supplying plant and making other needed improvements have been considerable, the best refining methods extant having, it is claimed, been introduced into these works. In the method here employed, a modification of the steam process, a cylindrical cast-iron retort about ten feet in height, is provided. Into this, through a trap in the top, the ore is fed, while through a similar aperture, near the bottom, the exhausted charge is withdrawn. Below this last mentioned opening is placed a perforated diaphragm of boiler iron, on which the charge rests. The compartment beneath this plate is bowl shaped and furnished with a pipe for discharging the melted sulphur. When the upper compartment has been filled with ore and the doors securely closed superheated steam is blown in. The sulphur melts and passing through the perforated plate is drawn off as often as required. This apparatus is more fully described in a paper prepared by Mr. D. Van Lennep and published in the *Engineering and Mining Journal*, of New York, October 14, 1882.

Whatever else may be said in explanation of the indifferent success that has thus far attended the efforts of this company, certain it is such result cannot be attributed to any defect in the article turned out by them, the product of their works having been equal to the best offered in the San Francisco market. Their sulphur has, in fact, proved to be as pure as the best French roll brimstone. Nor have manufacturers here, or the trade generally, shown any prejudice against the product of these Nevada mines. On the contrary, they have given it a preference whenever it could be obtained at the same price as the imported article, which latter has undergone a steady decline ever since the manufacture of sulphur was commenced on this coast, and chiefly by reason of such manufacture. The trouble with these Nevada companies, as with most others that have engaged in this business here, has been twofold. First, the great cost of making the sulphur, and second, the cost of getting it to market, the latter alone amounting to nearly twenty dollars per ton. With some improvement in this respect, these companies could, no doubt, make sulphur with profit, as they have the raw material of fair quality in good supply.

Another considerable deposit of sulphur in Nevada is located near that remarkable group of thermals, known as Steamboat Springs, in Washoe County. The mineral occurs here in a belt of light-colored earth, and underlaid with magnesian limestone. It is the product, no doubt, of solfataric action, which is still going on with considerable intensity at this place. The sulphur is found in the above formation in small bunches and strata, some of it quite pure, but the mass largely mixed with earthy matters. These deposits have been exploited by means of shafts, pits, and open trenches, but with such disappointing results, that operations were suspended several years ago, and have not since been resumed, nor are they likely to be very soon, as the mineral can be collected here only at considerable trouble and expense. Deposits of sulphur occur at several other places in this State, notably at a point ten miles north of the Great Humboldt Salt Marsh, also near the Fish Lake borate fields, in Esmeralda County.

CONSUMPTION AND SUPPLY.

The consumption of sulphur on this coast is comparatively large, having amounted lately to about 3,500 tons per annum, the average for more than twenty years past having been at least one half as much. Of the quantity consumed the Judson acid works, in Contra Costa County, and the Golden City acid works, in San Francisco, use up annually about 1,000 tons each, mostly in the manufacture of sulphuric acid; the several smaller works, of which there are four in California and one in Nevada, taking altogether some six or eight hundred tons. The balance of the sulphur used in California, say 600 tons, some being exported, goes to meet the requirements of the vine growers—here considerable—the powder works, the druggists, and the miscellaneous manufacturers.

The supply of sulphur for this coast has, with the exception of that sent from Nevada, been obtained mostly from Sicily, a part having of late years come from Japan. From both of these sources this commodity can, by reason of cheap freights, be laid down in San Francisco at rates that leave the domestic producer little margin for profit. Foreign ships coming to this port to load with wheat bring sulphur at low freight charges, taking it in sometimes for ballast, the same being the case, also, with vessels coming from Japan. Hence the low prices for this article that for a long time past have ruled in the San Francisco market, rendering it difficult for the home to compete with the foreign producer, notwithstanding refined sulphur is subjected to a duty of $10 per ton and flowers of sulphur to a duty of $20 per ton, with 15 per cent ad valorem added; crude sulphur being admitted free. These duties would sufficiently protect the home producer were they actually enforced, which, it is claimed they are not, large quantities of refined being imported under the name of crude sulphur, thereby defrauding the Government of its dues and depriving the home maker of the protection it was intended he should enjoy.

While the imports of sulphur at San Francisco have been considerable, exports have been trifling, consisting of thirty-five or forty tons sent yearly to Mexico, and still less to other of our neighbors. The price in this city has not for the past ten years exceeded $45 per ton. For several years past it has ruled at about $35, being just now somewhat less.

IN THE EASTWARD LYING TERRITORIES AND OLDER STATES.

Outside of Nevada there is very little sulphur made anywhere in the United States, although deposits of this mineral are reported to occur abundantly in Utah, Wyoming, Montana, and New Mexico; also more sparsely in Louisiana and Virginia. Sulphuric acid is, however, manufactured to a greater or less extent in nearly all the older States of the Union, New Jersey, Pennsylvania, Maryland, New York, and Ohio being the largest producers of this commodity, which is made principally from crude Sicilian sulphur imported for the purpose, duty free, some being also made from pyrites. The imports of Sicilian sulphur into the United States have increased from 27,596 tons, valued at $765,024, in 1872, to 101,595 tons, valued at $2,674,449, in 1882. Albert Williams, in his recent work expresses the opinion that the manufacture of sulphuric acid will grow into a very important industry in some of the older States, and that possibly most of this acid will in time come to be made from pyrites, as supplying a cheaper material for the purpose than brimstone.

CRUDE SULPHUR OR BRIMSTONE IMPORTED INTO THE UNITED STATES DURING THE FISCAL YEARS SPECIFIED—SPECIE VALUES. (FREE OF DUTY.)

Years.	Tons.	Value.	Years.	Tons.	Value.
1872	27,596	$765,024	1878	47,922	$1,173,156
1873	45,340	1,300,626	1879	65,919	1,487,698
1874	41,539	1,260,140	1880	83,236	1,927,502
1875	39,584	1,255,100	1881	105,438	2,713,494
1876	48,966	1,473,678	1882	97,956	2,627,402
1877	43,443	1,242,788	Calendar year 1882	101,595	2,674,449

REFINED SULPHUR IMPORTED INTO THE UNITED STATES DURING THE FISCAL YEARS SPECIFIED—SPECIE VALUES. (DUTIABLE.)

Years.	Cwts.	Value.	Years.	Cwts.	Value.
1872	2,027	$4,795	1878	6,628	$14,924
1873	2,117	5,180	1879	5,126	10,963
1874	1,709	4,129	1880	3,180	5,530
1875	535	1,399	1881	3,072	6,121
1876	2,375	5,668	1882	7,891	15,651
1877	29,039	48,868	Calendar year 1882	6,895	13,578

SULPHUR EXPORTED FROM THE UNITED STATES DURING THE FISCAL YEARS SPECIFIED.

Years.	Crude.		Refined.		Years.	Crude.		Refined.	
	Tons.	Value.	Cwts.	Value.		Tons.	Value.	Cwts.	Value.
1872	------	------	103	$270	1878	------	------	------	------
1873	5	$362	224	1,062	1879	------	------	39	$98
1874	------	------	------	------	1880	------	------	94	221
1875	------	------	130	344	1881	------	------	------	------
1876	------	------	------	------	1882	------	------	587	1,221
1877	------	------	1,086	2,688	Calendar year 1882	------	------	979	1,973

Some idea of the magnitude of the sulphur trade in Europe may be gained from the following figures: In 1868, 453,824,000 pounds of sulphur were imported into England from Sicily. In 1870, the total production of Europe was 785,400,000 pounds, not including that recovered from soda waste. The yearly imports of sulphur into England from Spain, Germany, and Norway is very great. One author estimates it at 1,000,000 tons. This is probably a mistake.

Sulphurets and Sulphuret of Iron—see Pyrite.

Sulphuret of Silver—see Argentite.

144. SYLVANITE. Etym. *Transylvania.* Telluride of Gold.

This rare mineral is said to exist in the Melones and Stanislaus mines, with other tellurium minerals.

145. TALC. Steatite, Soapstone, French Chalk.

This is a soft mineral, generally foliated, except where it occurs in rocky masses as soapstone, when it is granular or crypto-crystalline. When pure it is of a green, white, or yellowish color, with a greasy or soapy feel. H.=1—2.5. Sp. gr.=2.55—2.78. It is practically infusible, and is not decomposed by acids. It is usually found associated with serpentine, chlorite, and talcose schists, and forms an important constituent in some rocks. Talc is a hydrous silicate of magnesia and iron, sometimes containing alumina and other bases. Talc schist is an aggregation of scaly talc, with, frequently, quartz, feldspar, magnetite, mica, and other minerals. The massive variety of talc (soapstone) is used as a fire-resisting material, in place of brick, for lining stoves and furnaces. It is easily sawed into the forms required, and answers the purpose when the greatest extremes of heat are not used. The fine-grained talc is used for marking on cloth by tailors, and for dusting into tight shoes and gloves. It is used to some extent as an anti-friction material, and in the manufacture of paper. A fine crystalline variety, from Lower California, is used in the manufacture of paper hangings to give a silky gloss to the surface.

Steatite has been employed here to some extent in the manufacture of an infusible felting, and a fireproof paint, for which uses it is well adapted. This felting is applied to steam boilers and pipes, and being a non-conductor of heat, saves much fuel. As this mineral is abundant, and can be employed for a variety of purposes other than the above, it will, no doubt, come gradually into larger use. About 30,000 tons of talc are mined annually in the Eastern States, worth at the mines $12 per ton. This mineral is imported into the United States from Italy, Austria, and France, to the value of about $21,000 per year.

Talc is in considerable demand in Europe, as will be seen by the following extract:

LONDON, March 11, 1884.

To the Editor of the Mining Record:

SIR: It may be of interest to some of your readers to know that lump talc, or soapstone, is wanted in this country, and we understand it is to be obtained in North Carolina; there may be some elsewhere; free from veins; it should be free from iron, also in a firm state. Hoping you will consider this worthy of insertion.

O'HARA & HOAR,
Mineral Merchants, 12 Lime Street.

Soapstone occurs in numerous localities in the State. At the Alabaster lime quarry, Placer County, soapstone found near by, is used for lining the furnaces, and proves to be very refractory. There seems to be no reason why it should not wholly replace the costly imported fire-brick formerly used. I am informed by Mr. C. P. Dubois, Superintendent, that soapstone is used successfully in the furnaces at the Julian and Alabama mines, in the above county. The works of the Stockbridge Soapstone Quarry Company lie in Section ——, Township 15 north, Range 9 east, half a mile from Long Ravine toll gate, about nine miles southeast from Grass Valley, and within a quarter of a mile of the Colfax and Nevada City Narrow Gauge Railroad. This deposit was formerly worked for gold, which it contains in small quantities. The talc was crushed under edge wheels of cast iron, running in a bed of iron plates, at the rate of thirty-five tons per day. Owing to defective manipulation, or the peculiar nature of the material worked, the results were so unsatisfactory that milling for gold was discontinued. It was then worked for soapstone with somewhat better success. The stone, which seems to be of good quality, is cut with circular saws into slabs and brick-shaped blocks, which have given satisfaction as a fire-proof material. Twenty thousand bricks have been sold at fifty dollars per thousand, but, owing to high freight and limited market, the manufacture has been from time to time suspended. At the time of my visit, Charles Leech, of Grass Valley, was proprietor, and Frank Herrold, of Colfax, manager. The quarry is worked by an open cut, one hundred and ninety feet above the mill; the incline is steep, but is overcome by a tramway, on which two cars run. The following localities are represented in the State Museum:

(172,) soapstone, Placer County; (352,) talc, seven miles from Mount Hamilton, Santa Clara County; (2276,) talc in quartz, Yosemite gold mine, Mariposa County; (578,) Yuba County; (908,) eight feet thick, Tuolumne County; (1443,) fourteen miles below San Pedro, Los Angeles County, on the coast; (1459,) wall rock, Maryland mine, Grass Valley, Nevada County; (1654,) Fresno County; (1685,) soapstone, two miles northeast of Jackson, Amador County; (1864,) soapstone, Stockbridge Soapstone Works, near Colfax, Placer County; (2050,) Taylorville, Paper Mill Creek, Marin County; (2270,) Soapstone Mountain, Kern County; (2366,) soapstone, Tule River, Tulare County; (3644,) cut in the form of bricks and the same size, of good quality, and suitable to be used as a substitute for fire bricks, Lewis, Mariposa County; (3724,) talc, much resembling French chalk, Pine Flat, Sonoma County;

(4247,) talc foliated, with chalcopyrite, San Diego County; (4472,) near Murphy's, Calaveras County; it is also found at Rocky Hill and Jenny Lind Hill (Trask); Rock Island Hill, Plumas County (Edman); and near Lone Pine, Alabama Range, Inyo County, is found a peculiar greenish, semi-translucent variety, not exactly like soapstone, but micaceous feeling (Aaron).

TCHERMIGNITE—see Alum.

TELLURIC GOLD—see Sylvanite.

TELLURIDE OF SILVER—see Hessite.

146. TELLURIUM—see also Altaite, Calaverite, Hessite, Petzite, and Tetradymite.

Tellurium is a white metal, brittle, and easily fusible. Its equivalent or combining weight is 64.2 in the old system of notation, which is doubled in the new. The symbol used by chemists to express this element is (Te).

Tellurium was discovered and named by Klaproth. The specific gravity of the metal is 6.257. The name tellurium is derived from the Latin word "*Tellus*," the earth. The word "telluric" has no reference to the metal, but implies, pertaining to the earth.

This metal is very rare on the earth, but exists in a gaseous state, probably combined with hydrogen, in the atmosphere of some of the fixed stars, as revealed by the spectroscope. It is particularly noticeable in Aldebaran. I think I am not mistaken in stating that it has not yet been discovered in the sun.

Tellurium, as far as known, is found only in ten rare minerals, as follows (the figures showing the percentage of tellurium in each):

1.	ALTAITE, combined with lead	38.2
2.	CALAVERITE, combined with gold and silver	56.0
3.	HESSITE, combined with silver	37.2
4.	JOSEITE, combined with sulphur, selenium, and bismuth	15.93
5.	Nagyagite, combined with sulphur, lead, silver, gold, and copper	30.52
6.	PETZITE, a variety of hessite (No. 3)	
7.	SYLVANITE, combined with antimony, gold, silver, and lead	44 to 60
8.	Tellurium, native, nearly pure	
9.	TETRADYMITE, combined with silver and bismuth	33 to 48
10.	Tellurite, doubtful	

Those in capitals have been found in the State.

Tellurium is not only fusible, but is volatile, and may be sublimed in a glass tube without change. When exposed to high temperatures it becomes oxidized to tellurous acid ($Te\,O_2$), giving off dense white vapors. If the experiment is made in a piece of clean charcoal before the blowpipe flame, a coating is formed on the coal. If this coating is touched by the point of the reducing flame, it disappears, tinging the flame at the same time bluish-green. This reaction is characteristic. Any substance containing tellurium imparts a red color to boiling concentrated sulphuric acid. By these tests tellurium may be detected with certainty in any substance which may contain it.

The statement lately made in the papers, that a firm in San Francisco had paid $3,000 for one pound of tellurium, is evidently a mistake. At the rate of 51 cents per gram—at which price it is quoted in German price lists—a pound would only be worth $231 54. But when it is known that dealers make large discounts on their printed list of prices, and that wholesale rates are much less than retail, it is evident that so large a quantity as a pound could be bought for a much less sum.

Tellurium has absolutely no use in the arts. It is only prepared in small quantities as a chemical curiosity. All the reactions of the metal can be obtained by students from some of the minerals containing it, which are comparatively cheap. Like every other manufacture, its production is governed by the laws of supply and demand. In this case both the supply and demand are small; hence there is no inducement for its production, and those who do produce it naturally realize all they can from their small sales.

As an illustration of how the price of a commodity decreases when inducements are offered for its large manufacture, I have only to cite the metal sodium, which, a few years ago, was very high-priced for the same reason that tellurium is at the present time, although the supply was enormous, the dispersion of sodium being greater than that of almost any other substance. When the demand increased—it being required for the manufacture of sodium amalgam, and for the reduction of aluminum—new methods of producing it were discovered, and it has now become quite cheap and abundant.

Tellurium is found in considerable quantities in Schemnitz, Hungary, and in the silver mine of Sadovinski, in the Altai, associated with silver and lead. At the mine "Maria Loretto," in Transylvania, in sandstone, with quartz, pyrites, and gold. From this locality (Transylvania) the name "sylvanite" is derived. In the United States it has been discovered in Virginia and North Carolina associated with bismuth (tetradymite). Fine specimens come to us from the American mine, Sunshine District, Bowlder County, Colorado. In our own State it is not rare, being found in considerable quantities in several localities. The Melones mine, Calaveras County, is a celebrated locality. Splendid specimens of calaverite, hessite, sylvanite, and native tellurium associated with gold, have been shown in this city.

Metallic tellurium is principally obtained from the telluride of bismuth (tetradymite). The ore is first washed to concentrate it, then mixed with an equal weight of carbonate of soda or potash. The mixture is then made into a paste with olive oil, and heated in a closed crucible, first gently, to prevent frothing, then at a high heat. The fused mass is digested in water, which dissolves out the telluride of soda or potash, giving a deep wine colored solution. The bismuth and the charcoal resulting from the burning of the oil remain behind. If the liquid is allowed to stand exposed to the air, the tellurium gradually precipitates until it has all separated. This precipitation can be greatly accelerated by blowing air through the solution. The precipitated metal is purified by washing in dilute acid and distilling in an atmosphere of hydrogen.

The following letter contains a great deal of information concerning the tellurium minerals in California:

Palace Hotel, San Francisco, March 8, 1884.

Henry G. Hanks, San Francisco, Cal.:

Dear Sir: In answer to your question respecting the localities where tellurium is found in California, I can say that I have seen it in considerable quantities in Mariposa County, especially on the Merced River, not far from the Marble Spring mine. I have heard of it in the ores of the Mariposa Company and seen specimens said to have come from that property. Following the western branch of the mother vein, north, tellurium is found in large quantities in the Rawhide mine, near Chinese Camp, and in many mines around Tuttletown. Crossing the Stanislaus River, at Robinson's ferry, tellurium is found in masses, accompanied with massive gold, in the Stanislaus mine, and as telluride of lead in the Adalaide mine. In the Morgan mine, it appears as calaverite, petzite, and sylvanite, accompanied by gold in large masses; also, telluride of lead carrying gold. All the mines on Carson Hill and Chaparral Hill, where the Morgan mine is situated, have ores more or less associated with tellurium or tellurium compounds. I have heard of tellurium in Placer County, and I have seen it in Nevada, Butte, and Sierra Counties. In Sierra County, in the Oriental mine, very fine ores of tellurium are found associated with free gold and arsenical pyrites rich in gold. In the Murchie mine, Nevada County, very fine tellurides are found, and also in many mines on Feather River.

Ores of tellurium are difficult to work. In the raw way this mineral is detrimental to and sometimes utterly prevents amalgamation. It is volatile and disappears in roasting, carrying the gold with it, unless the greatest care is taken.

In *all* cases that have so far come under my observation the ores containing tellurium are very rich in gold, the tellurium invariably being rich in precious metals. In Bowlder County, Colorado, I have seen a compound of lead and tellurium, but in California I have never seen a simple compound of this sort—gold is always a factor and generally silver also.

Higher up in the mountains selenium is found also associated with gold. At the Oro Plata mine, in Murphy's, Calaveras County, seven miles from Carson Hill, compounds of selenium, gold, and copper are found. The mineral here is not massive, but exists in segregated crystals, very minute. The per cent of mineral in the ore is rarely over one half of one per cent and generally less than one eighth of one per cent, but the concentrates of this mineral are worth from $4,000 to $8,000 per ton. I have tested tellurium worth from $40,000 to $80,000 a ton from the various mines I have mentioned. I have an idea that tellurium accompanies the western branch of the mother vein throughout the State. I believe when more attention is paid to the refractory ores of California that tellurium and selenium will be found very valuable additions to the gold-bearing rocks of the State and worthy special study.

Very truly yours, Z. A. WILLARD.

147. TETRADYMITE. Etym. *Quadruple* (Greek). Bismuth, with Tellurium.

Professor Blake discovered a tellurium mineral in the Melones mine, Calaveras County, which he thought might be tetradymite, associated with gold. According to Willard, it occurs with massive gold in the Morgan mine, Carson Hill, and in the Melones mine, Calaveras County. It is said, also, to be found in the Murchie mine, Nevada County.

148. TETRAHEDRITE. Gray Copper, Fahlerz.

This mineral is a double sulphide of copper and antimony, of which there are numerous varieties. It is found in Mariposa County, with the gold in the Pine Tree vein; also with the gold in the same or similar vein at the Crown lode, Emily Peak, and at Coulterville, in several claims; in Calaveras County, at Carson Hill, in the large vein, and associated with gold. This ore, in decomposing, leaves a blue stain of carbonate in the quartz, and where it is found the rock is generally rich in gold (Blake). It is also found in the Golden Rule mine, Tuolumne County (Dana); in the White Mountain, Inyo County (Aaron); with barite and sulphur, both crystallized, in the Irby Holt mine, Indian Valley, Plumas County; and in the Jacob's Wonder mine, Panamint, Inyo County.

149. THENARDITE. Etym. *Thenard*, French chemist. Anhydrous Sulphate of Soda. ($Na\,O, SO_3$.)

Soda	56.3
Sulphuric acid	43.7
	100.0

This mineral dissolves in water, from which it may be obtained by crystallization in magnificent needle shaped crystals of hydrated sulphate of soda, which effloresce and fall to a white amorphous alkaline powder if left exposed to the air. When wet with hydrochloric acid and alcohol, and ignited, a golden yellow flame is obtained. It is found in great abundance in California and Nevada, with salt, ulexite, and borax, in beds of considerable thickness, resembling ice, which it is called by the borax workmen. Frequently the tincal crystals are imbedded in it, and are separated by solution in water. The thenardite being the most soluble, the crystals of tincal are set free and removed by perforated ladles. Considerable borax is lost in the operation, but it is still found to be economical. Sulphate of soda is the material required for the manufacture of carbonate and caustic soda. The first operation in the Le Blanc process is to form sulphate of soda by heating together salt and sulphuric acid in iron retorts. Sulphate of soda is formed, while hydrochloric acid gas is driven off by the heat employed, and condensed in water. The calcined sulphate is then heated with carbonate of lime and coal slack in a reverberatory furnace, forming "black ash," which is lixiviated and boiled down in iron pans to "soda ash," in which form it is commonly sold. This salt may be dissolved and crystallized to obtain "soda crystals;" or the solution heated with caustic lime, which precipitates the carbonic acid and leaves the solution "caustic." It is then evaporated to dryness, fused, and cast into sheet-iron drums, and is used for soap making and other purposes. This process is costly as to plant and waste in the first operation, viz.: the production of the crude sulphate of soda. Here, nature has produced it, and eventually it will be utilized in the manufacture of soda. Being anhydrous, thenardite would cost less for transportation, as there is no water of crystallization to pay freight on. Thenardite is said to exist in very large quantities at the works of the San Bernardino Borax Company. For further particulars, see third annual report of State Mineralogist, 1883.

THINOLITE—see Calcite.

TIN—see Cassiterite.

TINCAL—see Borax.

150. TITANITE. Sphene, Titaniferous Iron. Named from Titanium, one of the elements. Sphene is from the Greek for a wedge, from the shape of its crystals.

Titaniferous iron is found in iron sand in Spanish Creek, Plumas County (Edman). Sphene is found in small hair form crystals in the granite of the Sierra Nevada (Blake).

151. TOURMALINE.

Is a mineral almost invariably found crystallized, of all colors, from opaque black to nearly or quite transparent colorless. The usual colors are: *black* (schorl), *red* (rubellite), *blue* (indicolite), *green* (crysolite), *honey-yellow* (peridot), *colorless* (achroite).

All the tourmalines contain boracic acid from three to ten per cent. This mineral has never been worked for boracic acid, but is probably a source of that acid in nature, resulting from the decomposition of rocks containing it. The following analysis, selected from many, is given as an example of the general composition of tourmaline:

Silica	36.71
Boracic acid	6.49
Alumina	36.00
Binoxide of manganese	6.14
Sesquioxide iron	7.14
Magnesia	2.30
Lime	.80
Soda	2.04
Potash	.38
Fluorine	2.00
	100.00

Rubellite—Rose-colored Tourmaline.—This very interesting mineral is now observed for the first time in California, in the form of long slender crystals from one sixteenth to one eighth of an inch in transverse diameter, with the usual triangular section. Color, a beautiful rose pink, contrasting well with the matrix of white lepidolite. When ignited the color disappears and the mineral becomes perfectly white. Infusible. Locality, San Bernardino Range, Southern California (Blake).

Schorl.—San Diego County, north side of the valley of San Felipe, in feldspathic veins (for description and figure see Rep. Geol. Rec. Cal., Blake, p. 304). Tuolumne County, large crystals are found in granite on the summits of the Sierras. In white quartz, Calaveras County; and in Contra Costa County, near the Bay of San Francisco; and in San Diego County, from whence a fine crystal was brought to San Francisco by Capt. Woodley. Tourmaline is named from "Turmalin" from "Turamali," the native name given to this mineral in Ceylon, from whence it was brought to Holland in 1703. Rubellite is derived from the Latin, *rubellus*, a diminutive of *ruber* (red).

TRAVERTINE—see Calcite.

TREMOLITE—see Amphibole.

152. TRONA. Etym. Egyptian name. Sesquicarbonate of Soda. ($2NaO, 3CO_2+4HO$.)

Soda	37.8
Carbonic acid	40.2
Water	22.0
	100.0

This mineral is found with salt, thenardite, tincal, and gay-lussite, at the works of the San Bernardino Borax Company, and is utilized to some extent in the manufacture of borax. It is also found in Death Valley, Inyo County, and at other localities in the Mojave and Colorado deserts.

The extraordinary deposit of carbonate of soda near Ragtown, in the State of Nevada, has obviated the necessity of our looking to any other source for a present supply of the crude material, which can there be obtained in almost unlimited quantity and at very little cost.

On removing a few feet of top soil the soda is found here in a solid mass extending to an undetermined depth. The deposit, over an area of several acres, has been opened downward for a distance of forty feet without showing any signs of exhaustion in that direction, nor have its exterior limits yet been reached on every side. This deposit is worked after the manner of an open quarry, large blocks of the nearly pure soda being broken out and removed to the banks of the pit, where they are left turned up on one edge until the water drains off, after which they are ready to be shipped to market.

This material, after being refined, is used chiefly for the manufacture of baking powder and washing powder, soda ash, washing crystals, etc. In making baking or yeast powder the soda is first converted into a bicarbonate.

The following is an analysis of this Nevada soda, by C. S. Rodman:

Carbonic acid	38.70
Soda	39.97
Water	19.42
Salt	1.88
Sulphate of soda	.39
Silica	.13
	100.49

The only extensive works on this coast engaged in the business of refining carbonate of soda and manufacturing it, is that of John Horstmann, situate on Bryant Street, in this city. For making baking powder, the English soda is employed; for all other purposes, the Nevada is used. Mr. Horstmann buys of this material about five hundred tons per year, he being the only large consumer of it in San Francisco. It costs, delivered here, an average of $45 per ton. The Nevada soda would answer for making baking powder equally as well as the English, were proper care observed in refining it. For all other purposes it is equal to the imported.

Mr. Horstmann reports such an increase of business as necessitates an immediate enlargement of his present works, it being his intention to now engage in the manufacture of soda ash and some other commodities not heretofore produced by him. But, notwithstanding such industry, our importations of the bicarbonate of soda from Great Britain increased from 549,950 pounds, in 1882, to 1,798,462 pounds, in 1883; there occurred, however, a heavy falling off meantime of our imports of soda ash and caustic soda from that quarter.

Tufa—see Calcite and Aragonite.

153. TURBITH MINERAL. Yellow Sulphate of Mercury.

Is not found in nature. Specimens taken from the interior of the furnaces at the Sulphur Bank quicksilver mine, Lake County, were exhibited by T. Parrott at the Paris Exposition of 1878, and at his request were delivered to the School of Mines, Paris, at the close of the Exposition.

154. ULEXITE. Borate of Lime, Tiza, Boronatrocalcite, Natroborocalcite, Tinkalzit, Cotton Balls, Sheet Cotton, etc.

Ulexite is a natural hydrated borate of lime and soda. This curious mineral was first found in the niter beds of Peru in small quantities, in small globular concretions, showing when broken interlaced, silky-white crystals; sometimes also inclosed crystals of salt or gypsum.

It was examined by Ulex. His analysis of a specimen from Iquique, Southern Peru, gave:

Boracic acid	49.5
Lime	15.9
Soda	8.8
Water	25.8
	100.0

The mineral was afterwards analyzed by A. A. Hayes, who proposed the formula ($CaO, 2\ BO_3+6HO$). He supposed the soda found by Ulex to result from mechanically mixed glauberite. For some time this mineral was called "Hayesene;" but Dana, in the last edition of his work on mineralogy, gives it the name of Ulexite, in justice to the first observer.

The following extracts from "Mineraux du Pérou," by A. Raimondi, Paris, 1878, seem to show the analysis of Hayes to have been a mistake.

Ulexite was first found in the Province of Tarapaca, then named Borax or Tiza—lately found in the Cordillere de Maricunga, at an altitude of 3,800 meters (12,464 feet). Mr. Raimondi calls attention to a widespread error found in works on mineralogy, as to a borate of lime without soda, under the name of Hayasene, which, in his opinion, does not exist in Peru. In 1853, while in the employ of the Government of Peru, he visited all the known localities of the borates in the Province of Tarapaca. He examined a large number of specimens, and made a great number of excavations, and his conclusions were that the sample of borate of lime called Hayesene was Ulexite, or Boronatrocalcite. Ulexite was found for the first time in 1836–7, in Tarapaca, forty or fifty kilometers from Iquique, under the crust that covers the nitrate of soda beds, nearly always in little rounded masses from the size of a hazelnut up to that of a large potato—color white, fibrous, and silky. Very often the balls of ulexite have in their interior a nucleus of glauberite. The first notice in the scientific press is found in the second edition of the mineralogy of Dana, 1844, page 243, in which the author says that he had received a communication from Mr. Hayes, descriptive of a new mineral, under the name of borate of lime (*borocalcius obliquus*):

I repeat here what I have already said, that I am thoroughly convinced that the mineral described by Mr. Hayes as presenting rounded masses showing fibrous, white, silky crystals frequently accompanied by glauberite, is borate of lime and soda, and not simple borate of lime.

The many analyses which I made of all the specimens collected while Commissioner to the Government of Peru in 1853; and the analysis made in 1855 by the distinguished chemist Rammelsberg, of the material which presented all the physical characters of the doubtful Hayesene, establish in a manner nearly certain that in Peru there exists only a single combination of boric acid with lime, and that the combination is a double borate of lime and soda, described in works on mineralogy, under the name of ulexite or boronatrocalcite.

To complete what I have said on this important mineral, I give the composition of three specimens of boronatrocalcite found in a state of great purity in a very dry earth in the Province of Tarapaca, which appear in the report that I presented to the Peruvian Government in 1854.

These results agree with those obtained by Rammelsberg, only the specimens analyzed by the latter were not pure, because the boronatrocalcite was mixed with a small quantity of chloride of sodium and sulphate of soda and lime.

ANALYSIS OF ULEXITE, OR BORONATROCALCITE.

Substance Found.	By A. Raimondi.			By Rammelsberg.
	(1)	(2)	(3)	
Boracic acid	42.98	43.13	43.04	42.12
Lime	13.94	14.14	14.06	12.46
Soda	6.96	6.92	7.05	6.52
Water	36.80	35.75	35.85	34.40
Chloride of potassium				1.26
Chloride of sodium	0.16	Traces.	Traces.	1.66
Sulphate of soda	0.12	Traces.	Traces.	0.81
Sulphate of lime				0.77
Total	100.96	99.94	100.00	100.00

Notwithstanding the fact that Mr. Raimondi failed to find hayesene, there seems to be such a mineral, *a hydrous borate of lime, without soda.* Mr. N. H. Darton (American Journal of Science, 1882,) describes a mineral from Bergen Hill, New Jersey, to which he gives the name of hayesene, which had the following composition:

Lime	18.39
Boracic acid	46.10
Water	35.46
	99.95

Soda, silica, and magnesia, traces.

Ulexite is found at a number of localities on the Pacific Coast. It occurs in rounded concretions, from the size of peas to masses ten or twelve inches in diameter. Unless the so called cotton balls are carefully selected by hand, the percentage is greatly reduced by the admixture of sand, worthless soluble salts, and water. Much disappointment has been experienced from this cause. Shipments have rarely failed to be much lower grade than was expected.

As early as 1871, in the examination of ulexite and impure borates from the then newly discovered Columbus marsh borax fields, I accidentally discovered that very impure borate of lime in the cotton ball form could be concentrated and purified by very simple mechanical means, which information was given to the public in a report to the Nevada Consolidated Borax Company, November 11, 1871, in the following words:

Crude borate of lime can be easily and cheaply concentrated by simple mechanical treatment with cold water, in which it is nearly insoluble. A large vat should be constructed, in which the crude material is to be placed with a quantity of cold water. The contents of the vat must be kept in slow agitation by the proper machinery, until the borate of lime has been reduced to a pulpy form, and all mechanical impurity has settled to the bottom. When these conditions are fulfilled, a plug is withdrawn, and the contents of the tub allowed to run into a settling vat. Care must be taken not to allow the sand and other impurity to flow out with the purified borate of lime. In the settler, the borate of lime will soon fall to the bottom, and the clear portion contains biborate of soda (if that salt was associated with the borate of lime), which may be recovered by proper crystallization.

The purified ulexite may then be thrown on an inclined platform and allowed to drain, and then be dried in the sun.

The borate of lime so purified should have nearly the composition of the best natural product.

As borate of lime is quite voluminous in this condition, it should be compressed by powerful screws into a smaller bulk, as crude cotton is treated for the same reason. Ulexite containing twenty-four per cent of boracic acid has a market value in London of £18 per ton of 2,240 pounds.

There is a variety of ulexite called *sheet cotton* by the prospectors, which is sometimes quite overlooked. It is granular in appearance, but under the microscope it is seen to be ulexite in minute silky crystals. There is a specimen in the State Museum (No. 3590) which shows both varieties. Ten tons of boracic acid was made from this substance at the Phœnix Chemical Works at Columbus, Esmeralda County, Nevada, of which Mr. H. S. Durden was Superintendent. A sample of this acid (No. 3591) may also be seen in the State Museum. The following mechanical analyses of crude ulexite show the nature of the impurities:

No. 1.

Sand	9.25
Water hygroscopic	21.00
Soluble salts, mostly sulphate of soda and salt	17.36
Borate of lime	52.39
	100.00

No. 2.

Sand	Trace
Water	36.80
Soluble salts	11.04
Borate of lime	52.16
	100.00

The history of the discovery of ulexite in Nevada is given in detail in the third annual report. I have since gained the following information as to how the first specimen obtained came to be known as a valuable mineral:

In 1864 Albert Mack went to the newly discovered mines at Columbus, with George Daugherty, and in digging for water found the sample of borate of lime mentioned (third report, fol. 45), which he, for determination, presented to Dr. Partz, at Partzwick, Mono County.

Since the third report was published considerable borate of lime has been shipped to Europe, and some has been worked, from Borax Lake, near Grapevine Cañon, Kern County. The following is from the *Reno Gazette*, September 20, 1883:

Borate of Lime.—Nine carloads of borate of lime came in from Rhode's Marsh on the C. and C. by the V. and T. noon train to-day, consigned to Port Costa, California, where a ship is waiting to receive it for transportation to some foreign country.

The following localities of ulexite are represented in the State Museum: (4956), the variety technically known as "sheet cotton," containing free boracic acid, from Death Valley, Inyo County; (4957), borax made from it by decomposing it with carbonate of soda; (5291, 5292), are "sheet cotton" from Desert Springs Lake, Kern County, and (5293), boracic acid made from it by the Boracic Acid Manufacturing Company, J. B. Hobson, Superintendent.

Variegated Copper Ore—see Bornite.

155. VESUVIANITE. Etym. *Vesuvius.* Idocrase.

Is a silicate of alumina, lime, iron, etc., first found in the ancient lavas of Vesuvius, whence the name. It has been found in the Siegel Lode, El Dorado County (Blake). Some years ago, Mr. S. S. Taylor sent a fine specimen to San Francisco, from Spanish Ranch, California.

VITREOUS COPPER—see Chalcosite.

VITREOUS SILVER—see Argentite.

156. VIVIANITE.

Among a set of samples from Brea Ranch, Los Angeles County, sent recently to the State Mining Bureau, by Mr. J. W. Redway, of Los Angeles, was one of dark color and earthy texture, containing small nodular masses of a beautiful pale blue color, which were examined and found to be vivianite, or hydrous phosphate of iron. This mineral, which is rare in California, is interesting as leading to the hope that other phosphates, so important as fertilizers, may be found at or near the new locality. There is a specimen of vivianite in the museum of the State University, which is said to be from a California locality, but, if my memory serves me, this is attended with some doubt. It is reported also at Young's Hill, Yuba County, and near Oroville, Butte County, but no certain information has been obtained. The Los Angeles mineral occurs with asphaltum at the well known Brea Ranch deposit. The specimen is marked, "Gangue and Country Rock." The mass is a dark colored earthy mineral, with streaks and veins of asphaltic substance, the whole being evidently the sandy desert soil blown over liquid asphaltum and cemented by it. The vivianite is in small inclosed nodules, never larger than a pea, and generally smaller. The mineral is that variety known as blue iron earth or native Prussian blue. It is soft, pulverulent; under the microscope, crypto-crystalline; before the blowpipe, whitens for an instant, then blackens and fuses to a black magnetic globule. It is wholly and easily decomposed, by boiling hydrochloric acid; the solution reacts for iron, which, being separated, the solution gives precipitates with sulphate of magnesia and with molybdate of ammonia. In a closed tube it gives much water. The specimen has been numbered 3538, and placed in the State Museum, where it may be seen. The name vivianite was given to this mineral by Werner, after an English mineralogist, J. G. Vivian, who discovered it in Cornwall. When pure, it has the following composition, as given by Dana:

Phosphoric acid	28.30
Protoxide of iron	43.00
Water	28.70
	100.00

WOOD OPAL—see Opal and Quartz.

WOOD TIN—see Cassiterite.

157. WULFENITE. Molybdate of Lead.

This mineral is found as yet but sparingly in California, although it is abundant in Nevada and Arizona. It is represented in the State Museum by No. 5351, as small, perfect, tabular crystals, in ore from a mineral vein containing other lead minerals, six miles northeast of Cave Springs, Kern County. In Owens' River Valley, Inyo County, the miners are often vexed by finding a heavy yellow mineral in the pan or horn spoon, mixed with the gold prospect, which so much resembles the noble metal that they are frequently deceived by it. It is probably molybdate of lead, the specific gravity of which is from 6 to 7.

YELLOW COPPER ORE—see Chalcopyrite.

YELLOW OCHRE—see Limonite.

158. ZARATITE. Emerald Nickel, Hydrate of Nickel, Hydrated Carbonate of Nickel.

A rare mineral and ore that is never found in large quantities, generally as a thin coating on chromic iron and serpentine. It was observed by Blake on chrome iron in Monterey County. Dr. Trask reported it also with chrome iron at Panoches, Gabilan Mountains; Cañada of San Benito; and in Alameda County.

159. ZEOLITE. Etym. *Boil* and *Stone* (Greek).

The name zeolite applies to a group of minerals which includes at least twenty species; the name is therefore indefinite. They are all hydrous silicates of alumina, and generally are found in lavas and amygdaloids. There are several minerals in the State Museum from California which have been provisionally referred to the zeolites, pending future analysis and determination: (4155), in lava, North Fork mining district, Fresno County; (4214), in lava, Eureka, Humboldt County; (5084), in cellular lava, Soledad Cañon, Los Angeles County.

160. ZINC. See also Blende, Sphalerite, and Smithsonite.

Zinc is a metal of rather rare occurrence, never found in nature in a metallic state. Sp. gr.=6.861; atomic weight, 32.56 by old, and 65 by new system. The color of zinc is blue-white; it takes, when polished, a bright luster; fuses at 260 C. and boils at a white heat. With copper, it forms brass, one of the most useful and universal alloys. Zinc ores were known to the ancients under the names Calamine or Cadmia. The metal was not known to them, but brass was made by melting the ores of zinc and copper together. It is found in nature as sulphide (blende, or sphalerite), carbonate (smithsonite), and silicate (calamine), rarely combined with other elements or compounds. It is recovered from its ore by dry distillation, or sublimation. It is quite abundant in California, as sphalerite, or blende (which see). Oxide of zinc is extensively used under the name of zinc white as a pigment. The sulphate (white vitriol), is a powerful disinfectant.

161. ZIRCON. Jargon, Silicate of Zirconia (ZrO_2 SiO_2).

Silica	33
Zirconia	67
	100

H=7.5; sp. gr.=4.05—4.75; luster, adamantine; colorless, pale yellow, green, brown; transparent, opaque. It occurs in crystalline rocks; when these rocks decompose the extreme hardness of the zircon protects it against disintegration, and its specific gravity causes it to sink through loose formations to the bedrock, where it is found in California, Russia, Australia, and elsewhere in placers with gold. Zircon has not as yet been found in place in California, but is abundant in beautiful but small crystals in the alluvial sands. In cleaning up hydraulic mines it might be collected by the ton if it had any value, but zirconia is not much used in the arts. The sands and final concentrations from the hydraulic mines are very interesting, consisting as they do of gold, platinum, quartz, barite, magnetite, cinnabar, as well as zircons, and sometimes diamonds. Zircon sands are more abundant in some localities than in others; (4578), Spring Valley hydraulic mine, Cherokee, Butte County; (4892), hydraulic mines, Irish Hill, three miles north of Ione, and Arroyo Seco, Amador County, in shallow placers. It is also found in sands, Eagle Gulch and Rock Island Hill, Plumas County (Edman); in splendid crystals at Picayune Flat, Fresno County, and in the sands of the Navarro River, Anderson Valley, Mendocino County.

ABBREVIATIONS.

Aaron—Charles H. Aaron, a California metallurgist and author.

Blake—Professor W. P. Blake, author of a catalogue of California minerals, March, 1866.

B. B.—Before the blowpipe (in the blowpipe flame).

Bx.—Borax, used as a flux.

C. C.—Cubic centimeters, a French measure of capacity.

Ch.—Charcoal.

Dana—J. D. Dana, author of "A System of Mineralogy."

Edman—J. A. Edman, a California mineralogist, of Meadow Valley, Plumas County.

H.—Hardness.

O. F.—Oxidizing, or outer blowpipe flame.

R. F.—Reducing, or inner blowpipe flame.

Soda—Carbonate of soda, used as a flux.

Sp. Gr.—Specific Gravity.

Trask—Reports of Dr. J. B. Trask, first State Geologist.

Numbers in parentheses refer to Museum Catalogue.

ERRATA.

The following are some of the most important errors occurring in this volume, as far as noted. A number of minor typographical mistakes will be apparent to the reader:

Page 67, for "Agalmamolite," read Agalmatolite.
Page 67, tenth line from bottom of page, for "Calaveras," read Nevada.
Page 68, twenty-fourth line, for "Tschennigite," read Tchermignite.
Page 82, top line, after "Borax Lake," read Lake County, California.
Page 123, seventeenth line from top of page, for "which will be found," read will be found.
Page 135, for "one 'poud' equals thirty-six pounds or nearly," read one "poud" equals nearly thirty-six pounds, or 526.64 ounces Troy.
Page 145, fourth line from top of page, for "So far as the making," etc., read So far as making the very finest grades of pottery is concerned.
Page 149, for "E. T. Stein," read E. T. Steen.
Page 150, fourth line from top of page, for "shistose," read schistose.
Page 150, eleventh line from top of page, for "melanconite," read melaconite.
Page 152, for "Mess Copper," read Moss Copper.
Page 156, twenty-fifth line from top of page, for "intended to use sulphur," read intended to use sulphuric acid.
Page 156, thirty-first line, same error.
Page 158, second line from top of page, for "this mineral sulphate," read this mineral is sulphate.
Page 180, twenty-first line from top of page, for "Buryla," read Baryta.
Page 186, fifth line from bottom of page, for "experiment," read experience.
Page 231, seventeenth line from top of page, for "H 67," read H 6–7.
Page 276, ninth line from top of page, for "demorphous," read dimorphous.
Page 278, twenty-third line from top of page, for "Hamadau," read Hamadan.
Page 283, thirteenth line from top of page, for "sound pump," read sand pump.
Page 285, fifth line from top of page, for "in wide grate bars," read on wide grate bars.
Page 297, fifteenth line from top of page, for "Santa Meta," read Santa Rita.
Page 300, fifteenth line from top of page, for "mixed with sand; several grades," read mixed with sand several grades;
Page 305, thirteenth line from bottom of page, for "water where standing," read water there standing.
Page 317, twenty-seventh line from top of page, for "Stromeyite," read Stromeyrite.
Page 317, twenty-eighth line from top of page, for "contain," read contains.
Page 319, twenty-third line from top of page, for "manganese and iron," read manganese or iron.
Page 330, eleventh line from bottom of page, for "leavs," read leaves.
Page 354, top line, for "chryotile," read chrysotile.
Page 355, fourth line from bottom of page, for "which readily dissolve in excess," read the precipitate readily dissolves in excess.
Page 356, twenty-fourth line from bottom of page, for "metallic," read malleable.
Page 365, eighteenth line from bottom of page, for "sulphates," read sulphate.
Page 373, fifth line from top of page, for "nitrio," read nitro.
Page 381, thirteenth line from top of page, for "a large area, in bodies of mineral," read a large area; bodies of mineral, etc.

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